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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.S., and E. S. GREW, M.A.

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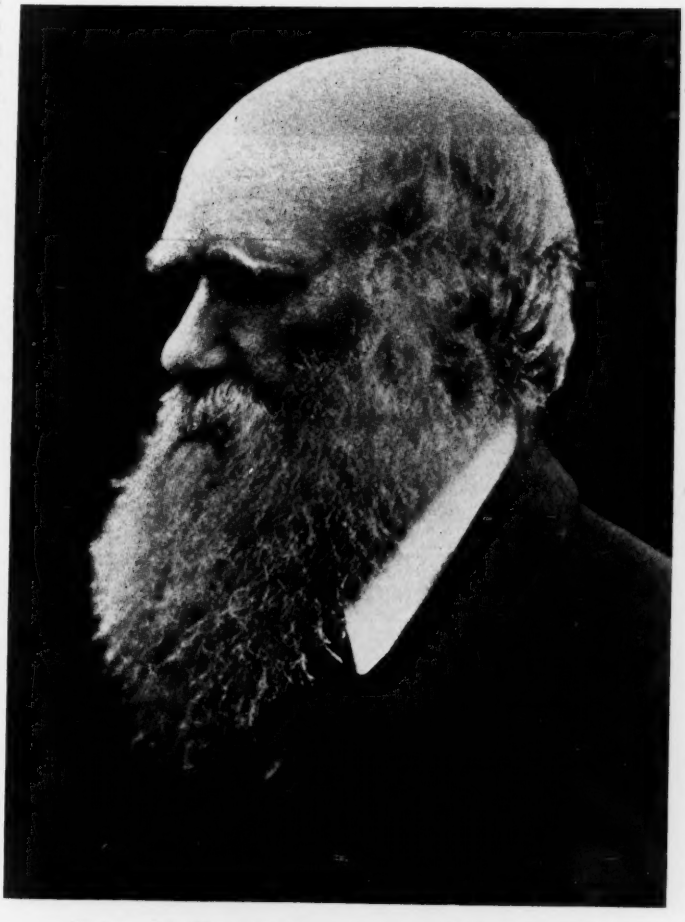
The Darwin Centenary.

ALTHOUGH it is difficult in the face of the large amount of attention which has been given to the celebrations of the Darwin Centenary at Cambridge to say anything about the occasion that has not previously appeared in print, we cannot pass it by without reference. The ceremonies began on Tuesday, June 22, with a reception by Lord Rayleigh, the Chancellor, in the Fitzwilliam Museum, and on Wednesday morning the Chancellor and Vice-Chancellor (the Master of Pembroke) received upwards of 240 delegates from the learned societies of foreign countries and of British dominions over seas.

One of the specially characteristic features of the Cambridge celebrations was the exhibition at Darwin's old College, Christ's, of portraits, caricatures, manuscripts, letters, and many other objects associated with him. One of the most gratifying of these was the bust of Darwin which was brought by the American delegates, and which is henceforward to occupy a place of honour in Christ's College Library. In a delightful article written for the Christ's College Magazine, Mr. A. E. Shipley recalls some of the more interesting, albeit scanty, facts that are known of Darwin's life as an undergraduate at Cambridge. "The Admission Book" at Christ's College, which in those days was very negligently kept, contains the following entry:—

> "Admissi sunt in Collegium Christi a Festi Divi Michaelis 1827 ad Festum ejusdem 1828, Octobris 15. Carolus Darwin admissus est pensionarius minor sub Mro. Shaw."



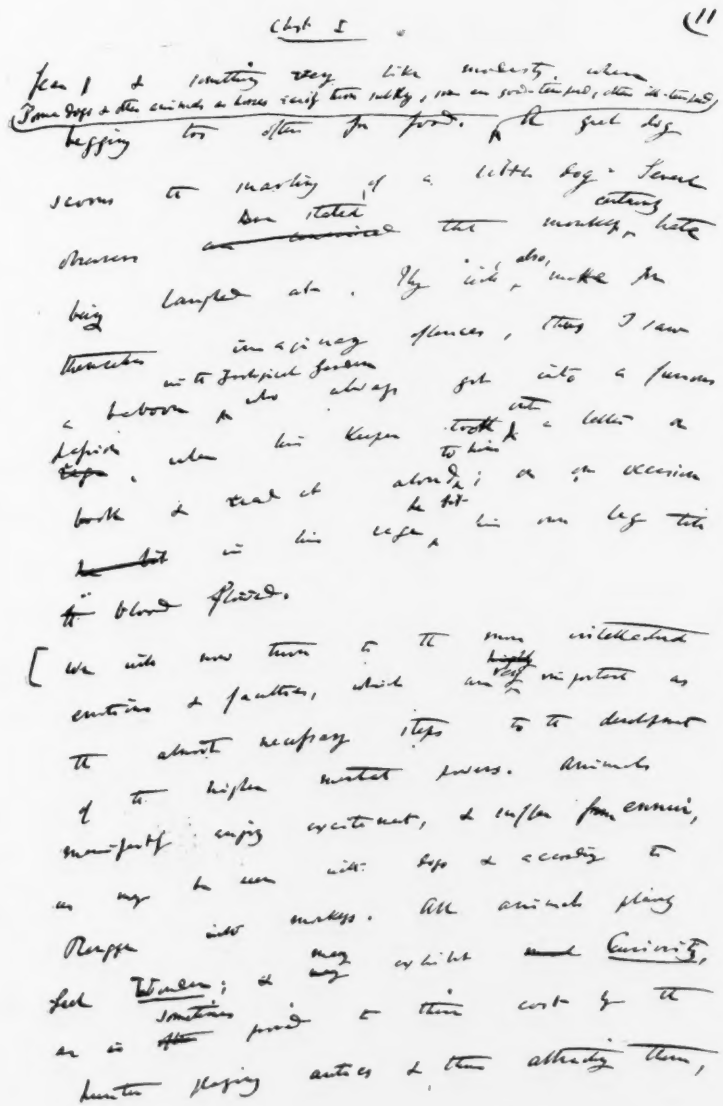
Photograph by Mrs. Cameron, taken in the Isle of Wight 1868.
Darwin wrote under this photograph: "I like this photograph better than any other which has been taken of me."

"On coming into residence, Darwin kept for a couple of terms over the shop of Bacon—Calverly's Bacon — the tobacconist, at that time in Sidney Street. For the rest of his time in Cambridge he had a pleasant panelled set of rooms on the south side of the first Court of Christ's, formerly occupied, according to tradition, by Paley, and since Darwin's time by the present Dean of Westminster and successive College Deans. . . . Among other absorbing pursuits was that of collecting insects, especially beetles. He was first interested in entomology by his cousin, W. Darwin Fox, of Christ's, who had kindred tastes and with whom he frequently corresponded — in fact, most of the letters written from Christ's College that remain were addressed to him. . . . After he had passed his final examination (in which he attained a respectable but not a distinguished place), Darwin had still one term to keep in order to proceed to his degree, and it was during this term and the subsequent May term when he was still in residence that, unvext by the prospect of examinations, Henslow persuaded him to begin the study of geology. There must have been something unusual about the

student, for he seems to have made friends with men much older than himself, and some of them, one would imagine, not very approachable. He records how he used to walk home at night with Dr. Whewell, and rejoices in his friendship with Leonard Jenyns. He became the friend of Adam Sedgwick, and in August, 1831, accompanied him on a geological survey in North Wales. It was on returning from this trip that he found a letter from Henslow informing him that Captain Fitzroy was willing to give up part of his cabin to any young man who would volunteer without pay to act as naturalist on the classic voyage of the *Beagle*. Captain Fitzroy, one recalls with amusement, took exception to the shape of Darwin's nose. 'He doubted

"Downe House," Dr. Darwin's Home, Downe, Kent. [*Photo by G. W. Smith.*

Room occupied by Charles Darwin at Christ's College. [*From the Christ's College Magazine.*



fear & something very like modesty, when begging too often for food. Some dogs and other animals as horses easily turn sulky ; some are good tempered, others ill-tempered. A great dog scorns the snarling of a little dog. Several observers have stated that monkeys certainly hate being laughed at. They will also make for themselves imaginary offences ; thus I saw a baboon in the Zoological Gardens who always got into a furious passion, when his keeper took out a letter or book and read it aloud to him ; on one occasion in his rage he bit his own leg till the blood flowed.

We will now turn to the more intellectual emotions & faculties, which are very important as the almost necessary steps to the development of the higher mental powers. Animals manifestly enjoy excitement, & suffer from ennui, as may be seen with dogs & according to Rengger with monkeys. All animals plainly feel *Wonder;* & may exhibit *Curiosity*, as is sometimes proved to their cost by the hunter playing antics and thus attracting them,

There can, I think, be no doubt that a dog feels shame, as distinct from fear, and something very like modesty when begging too often for food. A great dog scorns the snarling of a little dog, and this may be called magnanimity. Several observers have stated that monkeys certainly dislike being laughed at ; and they sometimes invent imaginary offences. In the Zoological Gardens I saw a baboon who always got into a furious rage when his keeper took out a letter or book and read it aloud to him ; and his rage was so violent that, as I witnessed on one occasion, he bit his own leg till the blood flowed.

We will now turn to the more intellectual emotions and faculties, which are very important, as forming the basis for the development of the higher mental powers. Animals manifestly enjoy excitement and suffer from ennui, as may be seen with dogs, and, according to Rengger, with monkeys. All animals feel *Wonder*, and may exhibit *Curiosity*. They sometimes suffer from this latter quality, as when the hunter plays antics and thus attracts them ;

Manuscript of Darwin's "Descent of Man."

whether anyone with my nose could possess sufficient energy and determination for the voyage.' But the two became close friends."

Five years later Darwin again settled in Cambridge, but only for a few months, while he spent his time in unpacking and distributing the collections which he had made on his South American voyage. He was apparently a good deal in College, and was evidently made a "Member of the Room," for his name occurs frequently in the Combination Room wine book. This

The United States Bust of Darwin.
(The bust is the work of Mr. William Couper.)

book, which dates back to pre-Napoleonic times, is one of the few records which the College retains of the presence of the great naturalist. "Whatever feeling Darwin had about the education he received at Cambridge," concludes Mr. Shipley, "he had a real love for the place, to which he sent all but one of his sons, and it is good to read the following lines in his autobiography:—

"'Upon the whole, the three years I spent at Cambridge were the most joyful of my happy life.'"

Darwinism and Modern Thought.*

THE University of Cambridge, with stately ceremonial and the added grandeur of a veritable army of scientific men brought from the ends of the earth, has just celebrated the centenary of the birth, not only of her most distinguished son, but of one of the greatest men the world has yet seen. Yet those who participated in this momentous gathering were but a privileged few, and even to them this great occasion will speedily become but a memory, though one dearly cherished. Thus it was wisely decided to commemorate this occasion by some more lasting memorial, one, moreover, which would be no less treasured by those who had not the good fortune to participate in these rejoicings.

This memorial has taken the form of a series of essays, commemorating both the birth of the author and of his epoch-making book, "The Origin of Species." These essays, twenty-nine in number, have been written by some of the ablest and most distinguished men of the day, and hence it will readily be understood that in the small space at our disposal the contents of this most delightful volume cannot even be summarised in a fashion proportionate to the merits thereof. This, however, is a matter of no great importance, for none who have any real interest in the world-moving work which Darwin accomplished would content themselves with such a substitute for the volume itself!

The book fittingly opens with a short introduction by one of Darwin's oldest and greatest friends, Sir Joseph Dalton Hooker, who did so much to champion the Great Cause during the stormy period that followed the publication of "The Origin"—a period during which every form of obloquy was hurled at its author.

The first essay is that of Professor J. Arthur Thomson, who gives a most scholarly summary of Darwin's Predecessors.

This is fittingly followed by a long contribution from the pen of the veteran August Weissmann, which will be read with lively interest by all, for it contains the distinguished author's most recent views of the theme which, during his whole lifetime, has absorbed his best energies. In one or two places we do not, however, quite follow him, as when he remarks that if a certain assumption was true "we should still be unable to infer from this alone how each of the numberless forms adapted to particular conditions of life should have appeared *precisely at the right moment in the history of the earth* to which their adaptations were appropriate, and precisely at the proper place in which all the conditions of life to which they were adapted occurred; the humming-bird at the same time as the flowers; the trichina at the same time as the pig; the bark-coloured moth at the same time as the oak; and the wasp-like moth at the same time as the wasp which protects it." This seems, if we do not misread this passage, to imply that these several apparently reciprocal relationships are really to be regarded as so many fortunate coincidences. He discusses with his characteristic lucidity the problem so often raised—the selection value of initial steps. And he gives some cogent arguments in support of his views thereon, which agree with those held by Darwin—to wit, that apparently insignificant

* "The Darwin Centenary." Essays in Commemoration of the Centenary of the Birth of Charles Darwin and of the fiftieth anniversary of the publication of "The Origin of Species." Edited by A. C. Seward. (Cambridge: University Press, 1909. 18/- net.)

differences may be of importance for the life of their possessor. This undoubtedly is true, because we cannot tell what are and what are not "insignificant" in this connection. But it may well be that some of these "insignificant differences" really have no influence one way or another, but if they are of blastogenic origin there seems good reason to believe that they may, having once started, go on increasing until, and unless, checked by natural selection. That is to say, not until the sometime insignificant character has become a conspicuous one is it called upon to justify its existence. Harmonious adaptation, germinal selection, sexual and natural selection, and animal coloration are other aspects of the great evolution theory which are handled with all the skill of a great master.

Professor Bateson contributes a brilliant essay on Heredity and Variation in Modern Lights. He writes with his characteristic fervour on his favourite theme. "The older writers," he remarks, "did not study Variation and Heredity. Darwin did, and so begat not a theory, but a science."

The essay on "The Descent of Man," by Professor Schwalbe, is not only charmingly written, but it is an admirable summary of one of Darwin's greatest books. But, more than this, the author adds a most valuable survey of the additions to our knowledge which have been made on the subject matter of this great book since its appearance.

An extremely able essay has been contributed by Professor J. W. Judd on "Darwin and Geology," which, even by the "mere biologist," will be read and re-read with genuine pleasure.

Professor E. B. Poulton, like Professor Bateson, writes in defence of an aspect of the great evolution problems which he has made peculiarly his own. He states his facts with a telling force, and argues with subtlety, so that his essay on the "Value of Colour in the Struggle for Life" will be read with zest, even by those who cannot follow as far as he would go.

This volume would certainly not have been complete without contributions from the Master's distinguished sons, Professor Sir George Darwin and Professor Francis Darwin. The essay of the former, on the "Genesis of Double Stars," makes fascinating reading, and this is saying much when it is confessed that the subject discussed is entirely strange to the writer of these lines. Professor Francis Darwin's contribution takes the form of an essay on his father's work on the movements of plants. As a model of impartiality it cannot be surpassed, while as a summary it is no less admirable. The author has, furthermore, greatly enhanced the value of his contribution by adding the results of later post-Darwinian work carried out, not only by himself, but by other workers in various parts of the world.

Of the other contributions in this most wonderful book—wonderful because of the breadth of its scope and the remarkably high standard of its contents—space forbids mention here. Suffice it to say that they include essays on Palæobotany, the Influence of Environment on Animals, the Geographical Distribution of Plants and Animals, the Biology of Flowers, Mental Factors in Evolution, Evolution and Modern Philosophy, the Influence of Darwin on Theology, Darwinism and Sociology—and on Religions, Language and History, and the Evolution of Matter.

If these last are here "taken as read," so to speak, it is but because the space at our disposal is inadequate to do them even scant justice, and not because they in any way fall below the high general level of the rest of the book.—W. P. P.

Darwinism and Ornithology.

By W. P. PYCRAFT.

BEFORE these lines appear in print the University of Cambridge will have celebrated the centenary of the birth of the worthiest and greatest of all her sons—Charles Darwin—and the fiftieth anniversary of the publication of that marvellous book of his "The Origin of Species." Marvellous because it marks an epoch in the history of mankind, establishing a new era, a new standard of thought, a new attitude towards the problems and mysteries of life, such as confront us all, in some form or another, during that long and dusty march to the grave whither we are all bound.

It required a splendid courage to do what Darwin did, for he challenged, and vanquished, the two great dragons, Orthodoxy and Tradition, which till then had held the world in awe; but the task was not accomplished without strenuous fighting. He made his attack on their domains by a way till then but little frequented—the narrow and dimly lighted path which led to the confines of that very imperfectly explored region—Biology. The effect of his first assault was tremendous, for thereby he shattered at once, and for all, the teachings of those who had become, by inheritance, so to speak, the guardians of this territory, and of those who had, in turn, adopted this teaching to point morals and adorn tales to serve other purposes. He showed, in brief, that the then current notions of the fixity of species were hopelessly wrong, and that the teeming life of the world was wrought

> "With many shocks that come and go,
> With agonies, with energies,
> With overthrowings, and with cries,
> And undulations to and fro."

Flushed with victory he passed on to further conquests, the chiefest of which was that in which he captured the very Standard of his opponents, that banner which proclaimed that man was made of a clay other than that out of which the rest of creation was fashioned.

He did not fight unaided; Wallace, his co-partner, Hooker and Haeckel are veterans still happily with us, Huxley and Lyell have followed their leader, but their works live after them. The host of distinguished men who have fought and are fighting is too great to enumerate. We say "are fighting" advisedly, for though the conquest is unquestioned, sniping and skirmishing still continue, and there are even some who have the temerity to assure us that "Darwinism is dead."

Let it not be supposed, however, that there is any desire on the part of Darwin's disciples to assume the ancient *rôle* of guardians of a dogma. Nothing would have been more abhorrent to the Master's mind. He himself was a merciless critic of his own work, and he always welcomed criticism as the most useful weapon for cutting the way to Truth.

In some directions immense progress towards this goal has been made, while in others singularly little has been done. If one were to be asked "What have Ornithologists done for Darwinism?" it would not be easy to give a ready answer. The great leader showed the way, but few have followed in his footsteps. Though a bountiful harvest of facts has been gathered, which can be drawn upon by all who will to further the great cause, these facts have been, as it were,

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brought in promiscuously, unwittingly, dumped down amid stalks of chaff, to await assortment!

It was left for Huxley, who was not an ornithologist, to be the first in the field to give us a classification of birds leavened with the new doctrine, a classification which was revolutionary, and in its main outlines still stands. Kitchen Parker was not an ornithologist, and to him we owe the bulk of the knowledge we possess to-day concerning the early history of the skeleton of birds. Garrod and Forbes were not strictly ornithologists, but to them we owe most of the post-Darwinian facts concerning Avian Anatomy. Beddard and Chalmers Mitchell similarly would not be regarded as ornithologists, but they have carried on the work of these earlier workers.

If we turn to the more typical student of Ornithology the result is no less disappointing. It might have been supposed that those who spent laborious days in the collection and examination of "species" would have accumulated a vast store of facts bearing on the problem of the evolution of birds. Yet Hutton stands almost alone in the endeavour to trace any possible meaning in the various combinations and permutations of colour which birds present. Magnificent monographs of gorgeously plumaged birds have been produced during the last half century, but no sort of generalisation as to the significance of this plumage has been attempted.

Oologists have distinguished themselves chiefly by their greed, and not at all by their intelligence.

The field naturalist has expended more energy in jeering at what he pleases to call Museum-men, "second-hand" naturalists, and other opprobrious terms than in endeavouring to pierce the mysteries enacted before his eyes; and all that the sportsman has done is to deprive us of some of our most interesting birds of prey!

It is not pleasant to have to say these things; on the contrary, one feels that in stating these ugly truths one is performing a very painful surgical operation without chloroform. But it will be good reading if any can produce evidence which seriously discounts what is here set down.

But there are bright exceptions, and one of the most noteworthy of these is furnished by a "field-naturalist" who has suddenly appeared above our horizon. Darwin, it will be remembered, was the first to point out the fact that the plumage of birds presented many grades of perfection in ornament, a gradual series of ascents from dull monochrome to more or less vivid hues; and, further, that these changes were first manifested, and perfected in the males, while the females and young still retained the ancestral livery. In the next phase he showed the female began to acquire, and finally completed the dress of the male, the ancestral livery appearing only in the immature female and young. Finally, after a series of similar phases, the young also put on the adult livery, and thus all trace of the original, ancestral plumage is obliterated, or is indicated only in allied species which have not similarly changed. Darwin contended that this process of evolution was due to "sexual selection"—to the preference shown by females to males which displayed a marked increase of pigmentation over their rivals. Thus dull-coloured males would tend to go unmated, and die without leaving offspring. The effect of such selection would be to gradually produce males of more and more striking coloration or ornamentation, and this, reaching a maximum, then appeared to be transmitted to the females, and finally to the young.

This theory seemed the more alluring, because it is a fact that birds of conspicuously brilliant coloration always, during courtship, appear to make the most of their charms by some form of display wherein these vivid hues are shown to their best advantage. The Peacock and Argus Pheasant are good examples of this, and were specially mentioned by Darwin in this connection.

Though from time to time these deductions have been called in question—even by Wallace himself, yet, for half a century, this theory has held its own. It would seem, however, that "sexual selection" must, after all, undergo some modification, for it has recently been shown, beyond cavil, that many of our most soberly-coloured birds "display" or perform what may be briefly described as "antics" in no wise distinguishable from those of birds of the most gorgeous hues; and, furthermore, that this display is not confined to periods of sexual exultation, but is made during periods of excitement of the most varied kind. The discovery of this fact we owe to Mr. H. Eliot Howard, who, in a masterly monograph on our British Warblers and their Life-history—a work which is not yet completed, and which for thoroughness and scope holds an absolutely unique place in ornithological literature—has brought to light some very remarkable facts and arguments. For fifteen years he has, with untiring zeal, devoted many months during each year to a study of these birds in their native haunts, so that his arguments are based on first-hand facts. He has conclusively shown that such soberly clad birds as Grasshopper Warblers and Chiff-chaffs—to take but two instances—assume postures as varied and as strange as any that are met with among birds which possess the most highly developed ornaments. If we cannot agree with Mr. Howard in all the conclusions he has drawn from the facts he has brought to light, it seems clear that Darwin's theory of sexual selection must undergo some modification, though it must still be admitted to play an important part in the choice of mates and the evolution of species. Briefly, we venture to think that the development of intense pigmentation, or, rather, the segregation, of pigment to form bright areas of colour must be regarded as the *indirect* result of sexual selection, and, not as Darwin supposed, the direct outcome thereof. This intensified pigmentation we conceive to be due to germinal variation; just as, in fact, all other permutations and combinations of structure are produced. Thus any variation in the direction of the development of bright bands or patches of colour having once started would, by their own potentiality, go on increasing with each successive generation, unless, and until, checked by one of Nature's sumptuary laws—Natural Selection. That is to say, it would increase until checked, because the further development would throw the bird out of harmony with its environment, either exposing it unduly to the attacks of its enemies, or hindering its flight. The Peacock and the Argus Pheasant, for example, would be quite incapable of performing long migrations; had these been necessary the huge train of the one and enormous secondary quills of the other would never have been developed.

What then, it will be asked, is the part played by sexual selection? Briefly this: Those males which are most demonstrative have the best chance of winning mates, and the most demonstrative birds are, it may be safely assumed, the most vigorous, the birds in which metabolism is most active; psychologically and physically they will be the most alert, and will oust their more phlegmatic rivals. Any tendency to the segregation of pigment—which the researches of Mr. Newbigin have shown takes place—and the consequent development of

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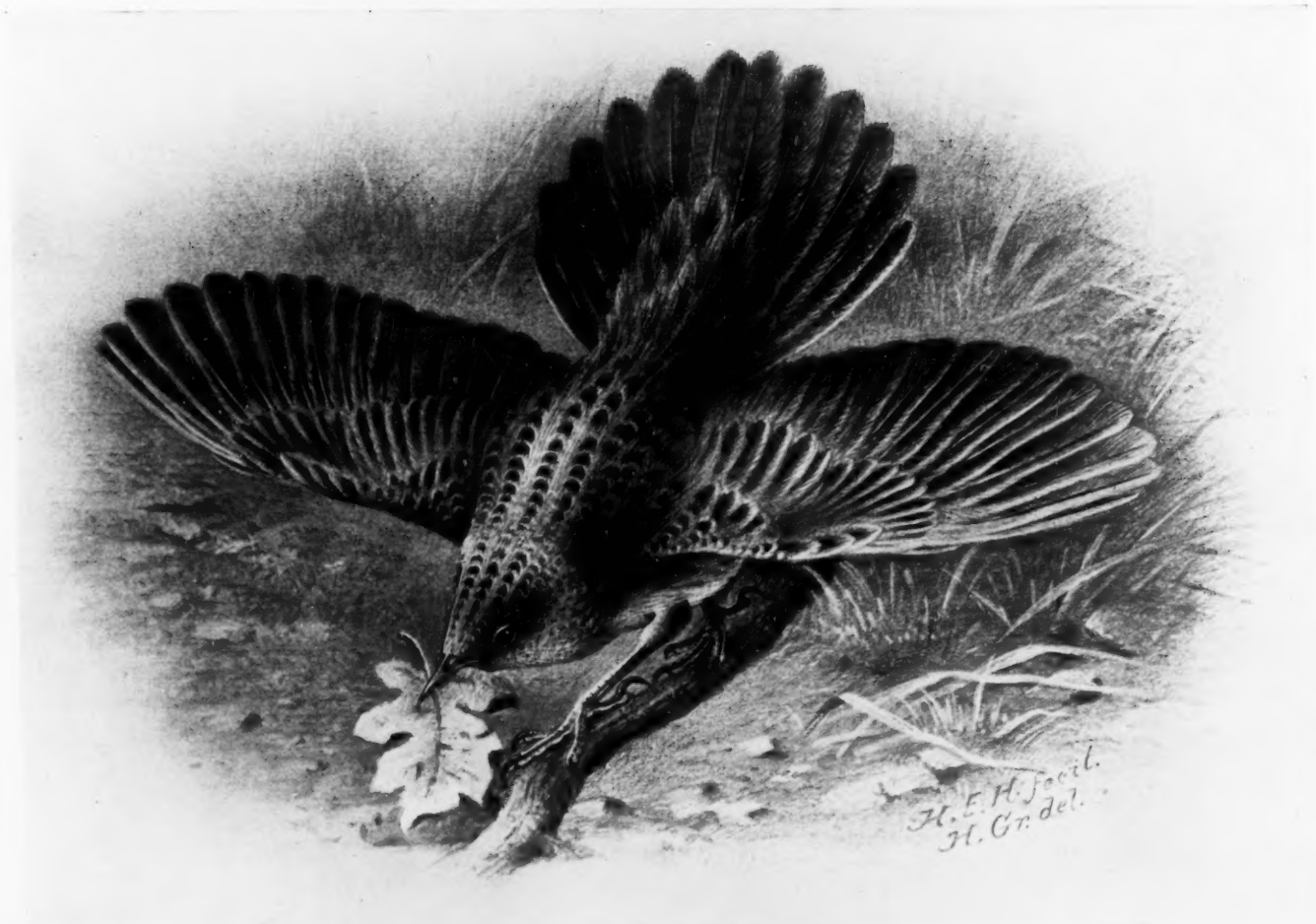

Grasshopper Warbler (Male).

(From Howard's British Warblers. By kind permission of the Author)

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bright colours, will of necessity heighten the effect of the display, and increase the performers' chances of success, but the colours, nevertheless, are to be regarded rather as correlated variations than the direct product of selection. Display *precedes* the development of brilliant plumage, it is not developed because of it; display may, indeed, take place, as Mr. Howard has shown, without the slightest accompaniment of conspicuous colour. Thus the coloration must be relegated to a subordinate position in the courtship; it may be the accompaniment of display, it is never the cause of it.

It seems but natural that this should be so, for it must be remembered that the brilliant colours of species as we see them to-day have been developed very slowly; the increment in any given generation is imperceptible. The process of their growth and maturity, as developed phylogenetically, is probably more or less truthfully repeated in the history of the race in such species as have an immature dress of sombre hues, and an adult livery of gaudy, or, at any rate, bright, or strongly contrasted hues. Take the case of the Black-backed Gulls, for example, which take between three and four years to arrive at the adult dress. The difference between the first and the fully developed plumage is most striking, yet the one passes into the other during successive moults by imperceptible degrees. Now, in the history of the race there is no written traditions to hand down to brightly-coloured species a record of the fact that things were otherwise with their ancestors; there is no standard of comparison for successive generations by which increments of colour can be appreciated. Each generation, in short, is without a standard of comparison, and unconscious of anything striking or peculiar in the plumage wherewithal it is clothed. Whatever is, is normal, is "natural" in this coloration. It is the "display" that tells. The pattern of the plumage is no more the result of "selection," on the part of discriminating females, in the case of birds of gaudy hues than in the case of birds of plain russet and brown, for these last are rarely unicoloured. Neither, then, are the hues which are part and parcel of this pattern "selected."

If we assume that coloration is the expression of germinal variation, just as more deep-seated structural characters, which also, having come into being, go on gathering in intensity till checked or suppressed by natural selection, then we can the more easily understand some of the present day puzzles such as are presented by, say, the common House Sparrow and the nearly allied Tree Sparrow. In the last-named male, female, and young are practically alike; in the first-mentioned the male differs conspicuously from the female and young, which last bear a close general resemblance one to another, and differ strikingly from the male.

One might pursue this theme much further, but enough has been said to serve our purpose—which is to show that the work begun by Darwin has remained almost neglected for half a century. Mr. Howard's recent attack on this problem is the most complete and most thorough which has so far been made!

A VERY curious application of the properties of calcium carbide has been made in Australia; namely, to the quick and easy determination of the quantity of water contained in wool, before shearing, an operation which is impracticable with very wet fleeces. A little wool is clipped off, weighed, and mixed thoroughly with an excess of calcium carbide, in a suitable apparatus. The acetylene produced by the reaction of the carbide with the water in the wool is determined by measuring its volume at constant pressure or its pressure at constant volume, by means of a scale so graduated as to give directly the proportion of water in the wool.

The Milky Way.

By J. ELLARD GORE, M.R.I.A.

THE nebulous zone of light known as the Milky Way or Galaxy is familiar to most people, and on a clear, moonless night forms a conspicuous feature of the nocturnal heavens. It is best seen in the country, for the lights and smoke of towns tend to obliterate its feeble gleam. It was known to the Romans by the name *via lactea*, and was called γαλαξίας κύκλος by the Greeks. It has attracted the attention of astronomers in all ages, and various hypotheses were advanced to explain its appearance. Plutarch saw in it the marks of Phaeton's accident, when he attempted to drive the chariot of the sun, and Aristotle thought it due to atmospheric vapours! The ancient Greeks and Romans thought it was "the road of souls." This road was supposed to have two gates. By that of Gemini the souls entered into the world, and by that of Sagittarius they went out and returned to the gods! Some of the original races of America held a similar idea. The Chinese called it *tien-ho*, the celestial river. It was also called by the ancient Romans the circle of Juno, Fascia, Vestigium Solis, Coeli Cingulum, and Orbis lacteus. Some of the ancients, however, thought it was composed of a multitude of faint stars, and this opinion was held by Democritus, Manilius, and Ptolemy. The accuracy of this view was confirmed by Galileo and Sir William Herschel, and is now the one universally adopted.

The first general description of the Milky Way was given by Manilius, a Roman poet, in an astronomical poem called *Astronomica*, written about the first half of the 1st century A.D. A description of its appearance is also given in the *Almagest* by Ptolemy, who observed in the 2nd century A.D., and it is frequently referred to by the Persian astronomer Al-Sufi in his "Description of the Fixed Stars," written in the 10th century. The southern portion was first described by d'Acosta in 1590. There was, however, no really scientific account of the Galaxy until Sir William Herschel described it in 1784 in the *Philosophical Transactions* of the Royal Society for that year. Horner did the same for the southern portion in 1804.

The first attempt at drawing the Milky Way was made by Wollaston in his celestial Atlas published in 1811. This delineation was used by Lubbock in his Atlas (1830). A drawing of the southern portion was made by Dunlop in 1828*, and by Sir John Herschel in 1834-38 at the Cape of Good Hope.† A drawing of the portion visible in Europe was given by Heis in his Atlas (1872), and of the southern portion by Gould in 1879.‡ A drawing of the Galaxy in both hemispheres is given by Houzeau in his maps published in 1878, but this is very diagrammatic and deficient in detail. Elaborate drawings have been made in recent years by Dr. Boeddicker (of Lord Rosse's Observatory), and by Easton. Portions of it have been photographed by Barnard, Max Wolf, and others.

The mean centre line of the Milky Way forms nearly a great circle of the celestial sphere. The position of the northern pole of this circle is, according to Professor Newcomb, in R.A. 12h. 44m., N. 26° 48′, or a little south of the star 31 Comæ Berenicis. The southern

* *Phil. Trans.*, Royal Society, 1828, p. 152.

† *Cape Observations*

‡ *Uranometria Argentina.*

pole is in the constellation Sculptor, about 10° south of the bright star β Ceti.

A careful examination of the Milky Way on a clear night will show that it is very irregular in appearance. In some places it is of considerable width, while in others it is comparatively narrow. In some parts it is bright, as in Sagittarius and near the Southern Cross, while in others it is comparatively faint, as in Auriga and Monoceros. The stars composing it are by no means evenly distributed along its course. Sir William Herschel's telescopic "gages" show an average of 161 stars in the constellation Aquila, and only 82 in Monoceros. It is also brighter in Aquila than in Monoceros. This shows that the increased brightness in Aquila is due to an increased number of stars, and not to less distance, as some writers have suggested. This increase in the number of stars in Aquila is confirmed by Professor Celoria, who finds from an enumeration of stars to about the 11th magnitude in a band of 6 degrees in width along the equator that the half of this zone, which includes the Milky Way in Aquila, contains 58,883 stars, while the other half, including Monoceros, contains only 43,822 stars. Herschel's "gages" included, of course, much fainter stars than those counted by Celoria. Houzeau's drawing also shows that it is considerably brighter in Aquila than in Monoceros, and this is confirmed by Heis' drawing, and also by the beautiful pictures of Boeddicker and Easton. With reference to the southern portion, Gould says, "Its brightest portion is unquestionably in *Sagittarius*, that in *Carina* being slightly inferior to this, as regards intrinsic brilliancy, although far more magnificent and impressive on account of the great number of bright stars with which it is spangled."

From an examination of the distribution of the faint stars composing the Milky Way and those shown in Argelander's charts of stars down to 9½ magnitude, Easton finds that there is "a real connection between the distribution of 9th and 10th magnitude stars and that of the faint stars of the Milky Way, and that, consequently, the faint or very faint stars of the galactic zone are at a distance which does not greatly exceed that of 9th and 10th magnitude stars."* A similar conclusion was, I think, arrived at by Proctor many years ago. Now, let us consider the meaning of this. Taking stars of the 15th magnitude, if their faintness were merely due to greater distance their actual brightness—if of the same size—would imply that they are at 10 times the distance of stars of the 10th magnitude. But if, at the same distance from us, a 10th magnitude star would be 100 times brighter than a 15th magnitude star, and if of the same density and "intrinsic brightness" (or luminosity of surface), the 10th magnitude star would have 10 times the diameter of the fainter star, and hence its volume would be 1,000 times greater ($=10^3$); and this great difference in size is not, perhaps, improbable.

The constitution of the Milky Way is not the same in all parts. The bright spot between β and γ Cygni is due to relatively bright stars. Other equally dense but fainter regions in Auriga and Monoceros are only evident in stars of the 8th and 9th magnitude, and the light of the well-known luminous spot in Sobieski's Shield, closely south-west of λ Aquilæ, is due to stars below the 9½ magnitude.

The correspondence in distribution between the stars of Argelander's charts and the fainter stars of the Milky Way shows, as Easton points out, that Herschel's hypothesis of a uniform distribution of stars of approximately equal size is quite untenable.

It has been suggested that the Milky Way may, perhaps, form a ring of stars with the sun placed nearly, but not exactly, in the centre of the ring. But were it really a ring of uniform width with the sun eccentrically placed within it, we should expect to find the Milky Way wider at its nearest part, and gradually narrowing towards the opposite point. Now, Herschel's "gages" and Celoria's counts show that the Galaxy is wider in Aquila than in Monoceros. This is confirmed by Easton, who says, "*for the faint stars taken as a whole, the Milky Way is widest in its brightest part*" (the italics are Easton's). From this we should conclude that the Milky Way is nearer to us in the direction of Aquila than in that of Monoceros. Sir John Herschel suggested that the southern parts of the Galactic zone are nearer to us on account of their greater *brightness* in those regions.* But greater width is a safer test of distance than relative brightness. For it may be easily shown that the intrinsic brightness of an area containing a large number of stars would be the same for all distances. For suppose any given area crowded with stars to be removed to a greater distance. The light of each star would be diminished inversely as the square of the distance. But the given area would also be diminished *directly* as the square of the distance, so we should have a diminished amount of light on an equally diminished area, and hence the *intrinsic brightness* or luminosity of the area per unit of surface would remain unaltered. The increased brightness of the Milky Way in Aquila is accounted for by the fact that Herschel's "gages" show an increased number of stars, and hence the brightness in Aquila and Sagittarius does not necessarily imply that the Milky Way is nearer to us in those parts, but that it is richer in small stars than in other regions.

Easton is of opinion that the annular hypothesis of the Milky Way is inconsistent with our present knowledge of the galactic phenomena, and he suggests that its actual constitution resembles more that of a spiral nebula.† On this hypothesis the increase in the number of stars in the regions above referred to may be due to our seeing one branch of the supposed "two-branched spiral" projected on another branch of the same spiral. This seems supported by Sir John Herschel's observations in the southern hemisphere, where he found in some places "a tissue, as it were, of large stars spread over another of very small ones, the intermediate magnitudes being wanting." Again, portions of the spiral branches may be richer than others, as photographs of spiral nebulæ seem to indicate. Celoria, rejecting the hypothesis of a single ring, suggests the existence of *two* galactic rings inclined to each other at an angle of about 20°, one of these including the brighter stars, and the other the fainter stars. But this seems to be a more artificial arrangement than the hypothesis of a spiral. Further, the complicated structure of the Milky Way cannot be well explained by Celoria's hypothesis of two distinct rings one inside the other. From analogy, the spiral hypothesis seems much more probable.

Considering the Milky Way to represent a colossal spiral nebula viewed from a point not far removed from the centre of the spiral branches, Easton suggests that the bright region between β and γ Cygni, which is very rich in comparatively bright stars, may possibly represent the "*central accumulations of the Milky Way*," that

* *Astrophysical Journal*, March, 1895.

* *Outlines of Astronomy*, tenth edition, p. 571.

† *Astrophysical Journal*, Vol. XII., p. 136.

is, the portion corresponding to the nucleus of the spiral nebula. If this be so, this portion of the Milky Way should be nearer to us than others. Easton also thinks that the so-called "solar cluster" of Gould, Kapteyn, and Schiaparelli may, perhaps, be "the expression of the central condensation of the galactic system itself, composed for the most part of suns comparable with our own, and which would thus embrace most of the bright stars to the ninth or tenth magnitude. The distance of the galactic streams and convolutions would thus be comparable with the distances of these stars." He thinks that the sun lies within a gigantic spiral "in a comparatively sparse region between the central nucleus and Orion."

As is now well known, the spectrum of the spiral nebulæ is continuous, showing that they are *not* wholly in the gaseous state—like the Orion nebula—but are probably composed of partially condensed masses like our own sun. Scheiner finds that the spectrum of the great nebula in Andromeda, which is distinctly spiral in form, is very similar to the solar spectrum, and "that the greater part of the stars composing the nucleus of the nebula belong to the second spectral class," that is, to the solar type. He thinks that this nebula "is now in an advanced stage of development. No trace of bright nebular lines is present, so that the interstellar space in the Andromeda nebula, just as in our stellar system, is not appreciably occupied by gaseous matter." He suggests that "the inner part of the nebula corresponds to the complex of those stars which do not belong to the Milky Way, while the latter corresponds to the spirals of the Andromeda nebula. The irregularities of the Milky Way, especially in streams, can be quite well accounted for, as Easton has attempted to do, if they are regarded as a system of spirals, and not as a ring system."

Evidence in favour of the spiral hypothesis of the Milky Way, as advocated by Easton and Scheiner, may be found in Kapteyn's researches on the proper motions of the stars. This eminent astronomer finds that stars with measurable proper motions—and, therefore, in all probability relatively near the earth—have mostly spectra of the solar type, and seem to cluster round "a point adjacent to the sun, in total disregard to the position of the Milky Way," and that stars with little or no proper motion collect round the galactic plane. He is also of opinion that the Milky Way resembles the Andromeda nebula, "the globular nucleus representing the solar cluster, and the far-spreading wings or whorls the compressed layers of stars enclosed by the rings of the remote Galaxy."

If, however, the Andromeda nebula resembles the Milky Way, as it probably does, it must be either a system of much smaller dimensions than ours, or else an external galaxy, that is, a system outside our stellar system. This I will proceed to show. Taking the extreme length of the nebula at $2\frac{1}{3}$ degrees, as estimated by the late Dr. Roberts, I find that in order that the Milky Way should appear to us of the same size as the nebula, the earth should be removed (along a line at right angles to the galactic plane) of about 50 times the distance of the Milky Way,* whatever that may be. This would evidently make the nebula an external galaxy.

Assuming that the external borders of the Milky Way lie at a distance of 3,000 light years, as estimated by Professor Newcomb, the earth should be removed to a distance of about 150,000 light-years. This would, therefore, be the distance of the Andromeda nebula were it comparable in size with the Milky Way. At this vast distance a star of the 12th magnitude would be reduced to a star of $20\frac{1}{2}$ magnitude, and if the nebula lies at this distance it is not a matter for surprise that the largest telescopes have failed to resolve it into stars, as no telescope yet constructed would show a star of the 20th magnitude. Supposing the nebula to be composed, like the Milky Way, of, say, 40 millions of stars, and taking their average brightness at $20\frac{1}{2}$ magnitude, I find that the total light of the nebula would be equal to that of a star of 1.5 magnitude. As the nebula is not nearly so bright as this, we may conclude that the component stars are fainter, or the distance of the nebula is greater. It seems, therefore, that the Andromeda nebula is either an external galaxy or else its dimensions are much smaller than those of the Milky Way. In the year 1885 a temporary star blazed out near the nucleus of this nebula, and the spectroscopic evidence tended to show that the star was *in* the nebula, as was pointed out by the late Mr. Proctor. Its magnitude was about 7 when first seen. If its original magnitude was, say, 20, this would represent a rise of 13 magnitudes. This seems a great increase of light, but a similar increase occurred in the case of Nova Persei (1901). At its brightest it reached the zero of stellar magnitude (or slightly brighter than Capella), and it is now known* that it was previously of the 13-14 magnitude, so that the increase of light in this case was probably quite as great as in that of the Nova in the Andromeda nebula.

But at the distance of 150,000 light-years the light of our sun would be reduced to that of a star of less than the 23rd magnitude. This would imply that the light of the new star was over 3 million times the light of the sun, and would indicate a body of enormous size. Now, the rapidity with which the star faded shows that the star must have been a small body and not a large one. We may, therefore, conclude that the nebula is not at the vast distance indicated by 150,000 light-years, and that its dimensions are much smaller than those of the Milky Way.

Sir John Herschel suggested in a letter to Proctor that our Galaxy (or stellar system) "may contain within itself miniatures of itself,"† and possibly the great nebula in Andromeda may be a miniature of the Milky Way, and the Magellanic Clouds also miniatures of our sidereal system.

From an investigation of the numbers and proper motions of the double stars in Struve's catalogue, Mr. Lewis comes to the conclusion that "the stars around us form a universe very much the shape of an egg, and that we are not situated in the centre. The larger diameter may be roughly estimated as equivalent to 600 light-years, and the smaller to 300 light-years."‡ This probably forms the nucleus of the spiral nebula represented by the Milky Way.

* Distance = d cot. 1° 10′, where d = distance of Milky Way.

* From photographs of the region taken before 1901.

† *Knowledge*, November, 1885, p. 21.

‡ Memoirs of the R.A.S., Vol. LVI., introduction.

AN ingenious burglar alarm, devised by a Dresden engineer, is described in a recent Consular Report. The apparatus consists of a curtain, which is drawn across the window or door, or around the safe that is to be protected. In the curtain are a large number of fine wires with small metal knobs, which connect the wire conductors at intervals. An electric current passes through the wires, and in case the curtain is disturbed in the slightest degree, the metal knobs are thrown out of contact with each other, thus actuating the burglar alarm. The curtain may also be used as a fire alarm in identically the same way.

XUM

Geology in County Antrim.

By EDWARD A. MARTIN, F.G.S.

THE remarkable sheet of basalt which now covers Co. Antrim represents but a portion of a great outpouring of lava which occurred in post-cretaceous times in North-Western Britain. Where exactly was the chief vent, or vents, we can only speculate. The dykes which now perforate some of the sheets of basalt are nowhere of sufficient importance to suggest that they were of any but secondary importance, and very possibly the site of the chief volcano is now covered by the

Columns at Giant's Causeway

Dykes at Giant's Causeway.

sea off the west coast of Scotland. That the period of volcanic activity was a prolonged one is evinced by the fact that the Antrim rocks were originally poured out in successive sheets, divided by periods when the surfaces of the igneous rocks were exposed to atmospheric agencies sufficiently long to modify the rocks into what may have been ancient soils. These are now represented by layers of red bole, and although the two great periods of the volcanic era, represented now by the upper and lower basalts, show a great thickness of this red rock between them, there are many thinner layers of bole contained in both upper and lower, which have probably been caused by somewhat prolonged exposure to the atmosphere.

Basaltic Stacks near Giant's Causeway.

Weathering of basalt at Giant's Causeway.

Lyell mentions that when the vegetable soil in the gardens of Catania was overflowed in 1669, it was burnt into a red brick-coloured stone. The idea that there were lengthy periods of quiescence is also borne out by the fact that between two of the lavas at the Giant's Causeway there is a bed of lignite. Owing to the regularity of the deposits it seems likely that the lava was gently poured out from the central crater or craters with little explosive effects, and this action has been likened to similar outpourings in the Sandwich Islands, whose monster craters, Kilauea and Mauna Loa, have in historical times covered up much of the islands with hard, black, shining lava. The dykes of the south-west of Scotland may have been in many cases filled-in fissures in the area of volcanic disturbance, and there were probably also intrusive sheets of lava which did not even reach the surface. The mass of Slemish represents a volcanic vent filled in subsequently by débris. By subsequent denudation of the rocks in which fissures occurred, and into which the dyke-forming material forced its way, the dykes now frequently stand out well above the surface of the land. At Ballycastle Bay there are some of them, which are here seen to pass through the much older carboniferous rocks. Fair Head, Co. Antrim, is a great mass of lava (dolerite), intrusive into carboniferous rocks, and the position of both rocks is well seen in walking along the coast from Ballycastle to Fair Head.

An ancient colliery is passed on the way, the shaft leading into the cliffs from the side of the road on the one hand, whilst leading out to sea are numerous volcanic dykes on the other. Strewed along the road are great boulders, in some of which fossil trees are clearly seen. The colliery at Ballycastle is an ancient one, and was probably worked five centuries ago. As long ago as 1726 Mr. Hugh Boyd called attention to some old workings which he had discovered.

Fair Head now stands 630 feet above the sea, and from the top one can, on a clear day, view Islay rising

Jointed basalt at top of Cave Hill, Belfast.

Looking from cave on Cave Hill towards Belfast Lough.

out of the sea on the north, with the Mull of Kintyre and the Ayrshire coast to the east. The dolerite on and about the Head has given rise to many smoothed and striated pavements, reminiscent of the great masses of moving ice which later came to pass southward over the plains, and to whose melting we owe those long and puzzling ridges of rock-rubbish known as eskers, which are scattered so plentifully over the igneous rocks of the county. At Ballycastle, too, there are interglacial sands and gravels, with terraces, resting on Boulder Clay, up to 600 feet on the flanks of the hills.

The parting of the lava at Giant's Causeway to contain the remains of the vegetation of the clay in the form of lignite has its counterpart in the fact that some stratified ash-beds at Ballypalidy contain also plant-remains, and it is in consequence of such beds that we are able to locate this volcanic period in Eocene times. One scarcely expects to find fossil remains in volcanic beds, but it is conceivable that lava which finds a vent beneath the sea, or which reaches the sea in its molten course, may enclose the organisms then in existence. Similarly, as is well known, there is a bed of volcanic ash at the top of Snowdon which encloses large numbers of fossils.

Between Portrush and Bushmills there are numerous fine sections showing the position of the lava overspreading the hard white chalk rock. In one remark-

able section a fault in the chalk has opened sufficiently wide to allow of its infilling with great rounded bomb-shaped lumps of basalt, and at first sight one is apt to imagine that here we have actually a volcanic neck or dyke, but it is evident by the absence of the usual changes which take place in the surrounding rock when a lava reaches it, that the infilling of the fracture was from above rather than from below. A broader mass of similar material now supports the ruins of Dunluce Castle. This now juts out into the sea, the chalk, into whose fissures the masses fell, having since been

Section showing basalt lying upon chalk near Cave Hill, Belfast.

Chalk stacks and basalt cliffs at Ballintoy. Rathlin Island in far distance.

denuded away by combined marine and sub-aerial action.

At the southern extremity of the basaltic plateau the junction of the underlying chalk with the igneous products of the time is well seen on the north of Belfast Lough. The line of demarcation is clear and distinct, as will be seen from the illustration. This is taken from the side of a dry valley on the south-west of Cave Hill, Belfast. The chalk here, as elsewhere, is highly indurated. At the top of the hill is an isolated block of igneous rock, exhibiting jointed structure. On the southern face looking towards Belfast Lough is a large cave in the same rock, from the interior of which our photograph was taken.

The rocky coast of Antrim is here and there broken

Smoothed and striated pavement on Fair Head.

Denudation at Western end of Basaltic Plateau.

by quiet bays, bounded on the land side by low-lying sand hills. Such a one is seen in passing westward from the Giant's Causeway, where the river Bush now makes a narrow entrance into the sea, but giving good evidence of an ancient estuary which has been reclaimed from the sea. In an easterly direction another such is found at White Park Bay, along whose strand lie the remains of many a kitchen midden, where bones, and teeth, and landshells may be turned up in quantities. At the eastern end of this bay is the village of Ballintoy, situated above the cliffs. The illustration shows here a mass of basalt which is bounded on both sides by hard chalk cliffs, and which is no doubt a true volcanic neck. But what is most striking here is the evidence we find of comparatively recent elevation of the land, in the form of raised caves in the chalk cliffs. These are now about 15 ft. above high water mark, and are the equivalents of the 25 ft. terraces which are found across the channel at Kintyre, Arran, and Rothesay. The caves are now high and dry, and are used for storage of nets and other fisherman's property. On the shore lie great blocks of basalt, which have fallen, and these are noticeable as exhibiting a rude columnar

Raised Cave in the chalk at Ballintoy.

Boulder clay at Port Ballintrae.

structure, but bearing a close resemblance to the cracking which takes place in the mud of a pond that has dried up. Here we have the true key to the cause of the columnar structure of the Causeway. The caves in the basalt and the chalk between the Causeway and Portrush, of which there are a great number, are generally within reach of the sea, and the White Rocks of Portrush give some excellent examples of marine erosion.

At the western extremity of the igneous plateau there is a sudden descent into the valley of the Limavady. An excellent study of the scenery, as here exhibited, can be seen from the top of Benevanagh. A peat-bog crowns its crater-like summit. Far down below one can see the river meandering with slow current towards

Basalt and chalk East of White Park Bay, rude columnar structure in block in foreground.

the sea, occupying but a small portion of its ancient flood-plain. And as one descends from the mountain to the plain, and casts one's eyes back to the mountain mass, one can see how that sub-aerial denudation is working upon it, and great blocks are detaching themselves from the main mass, and are rending the mountain to its very core. Abrupt as is the northern front of Benevanagh, it does not look down at once upon the waters of the sea as does Fair Head, but a great tongue of flat alluvial land stretches out to the north, all of

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which but yesterday, geologically speaking, has been wrested from the sea.

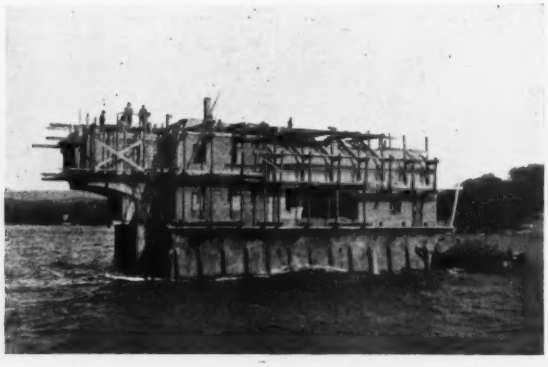
Although the most apparent rock in Antrim is igneous, the sedimentary basis of the county is seen to crop out frequently around the coast. At Larne and Portrush we find narrow outcrops of Rhaetic and Lias. The Bunter Sandstein also crops out around the coast, whilst on the east coast the old red conglomerate is seen between Cushendall and Cushendun. On the north, as we have seen, the chalk is constantly in evidence, so that we have in the north-eastern corner of Ireland plenty of variety in the matter of sedimentary rocks. More recently still we have, in the pliocene beds on the south of Loch Neagh, evidence of a southerly extension of this lake in early tertiary times, this lake being the oldest as well as the largest sheet of fresh water in Britain.

The erosive power of water is well seen at Glenarriff. In this beautiful glen we have a striking contrast to the scenery around it. Ferns, mosses, and liverworts line its banks, and there are luxurious growths of the flowering plants such as cannot be met with on the plateau above. In the higher parts of the glen the water is turbid with peaty constituents, but lower down as it tumbles over the red conglomerates it takes its colour from the rocks, and its waterfalls are wonderful to behold.

An Artificial Island.

By DR. ALFRED GRADENWITZ.

THE first artificial island ever constructed in the open sea has been recently completed by a firm of French constructors—Messrs. Schneider and Co. France had so far been dependent for the construction of her torpedoes on the well-known Whitehead firm, and only quite recently has the French Government installed a small factory for producing torpedoes of the same type. The Schneider Company proposed to enter upon the manufacture of a novel type of torpedo, independently



of any foreign constructors. As, however, extensive trials are required in order to adjust a torpedo (which, in itself, forms a miniature submarine), an experimental station had to be installed. No suitable site having been discovered on French coasts, Messrs. Schneider and Co. decided on building their station in the open Mediterranean Sea, in the form of an artificial island. Our photographs represent this remarkable construction in course of formation. As the island is placed on enormous foundations, while only the most resisting materials (mainly concrete) have been chosen for its construction, it is sure to withstand any impact of storm and waves.

CORRESPONDENCE.

Buttercups and Daisies, or the Classification of Plants.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—To some, classification is an idle word. Very learned people occupied in studying the structure of cells, etc., make it a vaunt to be unaware of the names of genus, order, and species. Classification was first of all a matter of convenience, a *memoria technica*, a means of ordering knowledge. But the more it attempts to be a *natural* classification the more it tends to re-mirror the genealogical tree of the group it deals with. Long ago Lindley remarked in his Botany that plants could not be arranged satisfactorily along a line. Some groups were found to arrange round some other group as a centre. This was taken note of as a great mystery. It was before the days of evolution, and it was somehow supposed to justify the idea cherished by the theological naturalists that "God did it all."

In Woodward's conchiology a somewhat similar attempt is made to work in mysticism by an elaborate theory of centres of creation, though to a travelling naturalist who has visited them it does not help to understand the workings of Nature, to say nothing of the trouble said centres must have been in during not very remote geological times, when they were volcanoes or dry land. As to plants, the mystery vanishes when it is realised that orders and genera are themselves branches of the genealogical tree of plants, and that less important orders will tend to group round more important ones just as twigs group round branchlets and branchlets round stems. Thus it cannot be gainsaid that the classification of plants as generally accepted by official Botany in its general outlines, and sometimes in its grouping of particular orders, gives here and there true glimpses of the genealogical tree of plants. For this reason the complete transformation of the accepted Hookerian system by Swiss botanists—and in this particular branch of science Switzerland has a high position—is of particular importance, and I should like to know how far English botanical specialists consider it to be justified.

For my part I see frequently in Western science the bias of race, patriotism, and even of unconscious religion, which the learned systematories themselves are, perhaps, quite unconscious of. The cranial index which wins us the missing link in palæolithic, reveals to us the highest types of humanity in British numbskulls. Has not all Asia—at any rate, all the intelligence of it—been laughing at this childish attempt of Western savagery to pose and impose its own superiority? And have not the Mongols, above all the Buddhist Burmese, and even the cruelly abused Andamanese, not to mention the prosperous Malays of Dutch India, the right to laugh? Whether the Swiss apotheosis of the daisy and the dethronement of the buttercup be due to latent religious bias or not, it looks very much as if patriotism had something to do with it.

I am aware that Grant Allen preached the cult of the sunflower and considered the daisy to be the most highly evolved type of plant, and that gifted writer can certainly not be suspected of buttering Western superstition with daisies or anything else. On the other hand, Christian piety cannot fail to see in the humble daisy, in the margharetas, and *buona robas* of the roadside, delicate symbols of its own superior passion-shop, and desire to say to it in presence of the hated golden-robed priests of the meadow, "Friend, go up higher," and to roll the latter down the classification ladder as low as to the fiends. Whether some such latent religious sentiment was present in the scientific Swiss mind, certain it is that the transformation of co-ordinates—the apotheosis of the daisy and the degradation of the buttercup—form the crux of their botanical classification. Far from being allowed to be so much as endogens, much less dicotyledons, the firs and cycads are classed as gymnosperms, while the buttercups are literally degraded as low as to the fiends—below the euphorbias, in fact; while the daisies and campanulas—waft her angels!—soar above Mont Blanc.

No one will hesitate to admit that campanulas and composites are closely related orders; in fact, I have never understood myself why they should be separated. If clover

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The Moon.

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does not form a separate order, why should chicory or phyteuma or jasione?

Snow mountains and high Alps certainly produce a fine type of humanity, they teach the need of unity and holding together—to put it briefly, to keep warm, and as with men and cattle, so with plants, all about the sources of the Rhine, along the wild Forcellina Pass, over close-cropped Alps, are scattered types of campanulas, grey and pallid with cold hugging their stems in close-packed whorls and the stem itself so stunted as almost to transfer them into china asters. And where but among the Alps are the composites in their true home, grandeur, and luxuriance? Some of them, the arnicas and the giant chrysanthemum (montanum), will not condescend at all into the valleys, not even below 3,000 ft. above sea-level. So of some flaming-tinted pyrethra and whole-leaved senecios. On the other hand, in the tropics, while, as a rule, the composites are hardly represented at all, the campanula has accommodated itself to heat and damp by developing into two distinct orders, the stylidias and goodeneovias. In Stewart's Island, where the climate is wintry, are several kinds of showy, shrubby composites, but in the whole of the temperate or sub-tropical Northern Island of New Zealand composite flowers are hardly represented at all, the commonest being a yellow button which has lost its rays and haunts damp spots by the roadside. In Java and the Malay Archipelago—at any rate, on the low-lands—I can only remember one, a plant like a diminutive ragwort, with orange flower heads, that possessed a strong, pungent, aromatic flavour. The same is also true of Australia, with the remarkable exception of Western Australia, of Ceylon, Southern India, and wherever I have been in the Malay Peninsula and the Andamans. But if a few orders belonging mostly to sub-arctic or mountainous regions are poorly represented in the tropics, a much greater variety of orders and forms of life occur in the tropics, whether in tropic seas or on tropic lands, both vegetable and animal, than in more frigid zones, and it would, therefore, be a strange circumstance if the highest type of plant should be one that adapted itself to live where a rigorous climate permits only a comparatively few orders to exist at all, and not be found rather where abundant damp and heat encourage the most varied and manifold development.

I do not wish to impugn Scotch thistles, which may be admirably adapted to Scotch heaths, but that they form the crown and glory of the whole of Nature's vegetable creation is a theory more likely to commend itself to Scotch cuddies than to Indian lotus flowers.

In this connection a word may be said about the scabius. Why this flower and its order should file past after the composite campanulas, heaven knows; the ligules and florets of the composites bear their campanulous origin clearly impressed upon them, but what remote resemblance has the four-lobed echium or statice-like floret of the scabius, seated on its round, hairy tuft, representing some abortive calyx, in common with the harebell? It is, indeed, much more like a composite origanum.

Yours truly,

Pension zim alten Dolder, W. W. STRICKLAND.
Zürich, Switzerland.
June 5, 1909.

Eclipse of Moon.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I beg leave to submit to your readers the stereoscopical picture of the moon's eclipse on June 3, 1909, obtained through my 5-inch equatorial refractor by means of two photographs made in an interval between 23.54 and 23.59 hours, Greenwich time.

Although it may be easily understood that a shade cannot be corporeal, the stereoscopical angle of both shades gives an interesting scope in the apparatus, because the moon appears to be situated in some way behind the *mass* of shade, and hence the panorama outstands with a certain grandeur, owing to the nature of all kinds of stereoscopical views, especially heavenlike ones.

Stereogram of Moon's eclipse June 3, 1909, by Salvator Raurich, Barcelona, Spain.

It has not been possible to make any particular observations here, owing to the clouds which came up, covering the totality. I could only ascertain through the troubled atmosphere a remarkable brownish tint.

Barcelona, Spain. SALVATOR RAURICH.
June 8, 1909.

NEW NATURALISTS' SHORT-FOCUS TELESCOPE.—An ingenious addition to the small short-focus telescopes such as are commonly used by naturalists has been designed by Messrs. H. F. Angus and Co., of 83, Wigmore Street. A cap containing an additional bi-convex lens is supplied with the telescope, and this, by still further reducing the focus, renders the instrument useful for watching insects, spiders, and other natural objects at convenient distances. At a distance of about twenty inches the addition of the bi-convex lens furnishes an actual magnification of about five diameters. Caps such as these could be adapted to any small telescope, and as they are quite inexpensive (3/6 for any size or power of lens required), the idea is clearly a very useful one. The telescope with appropriate cap, which has been sent to us by Messrs. H. F. Angus, is extremely well and neatly made and its definition is excellent. It is slung in a handsome black leather case, so that it can be carried like a small binocular.

XUM

A Tribute to Professor J. E. Keeler.

Spirals and Star Clusters.

BOTH the work of Professor James Edward Keeler in photographing the spiral nebulæ and the cosmogony of Chamberlin and Moulton which was founded on Professor Keeler's disclosure of the overwhelming preponderance of the spiral form in nebulæ will be familiar to readers of "KNOWLEDGE." As a memorial to Professor Keeler, and "in recognition of his great worth as a man and an astronomer," the Regents of the University of California have published reproductions of the principal photographs of nebulæ and clusters which he made with the Crossley Reflector at the Lick

The Spiral Nebula H. I. 53 Pegasi. Exposure 4 minutes.

Observatory. The cost of plates of the volume has been borne in part by the State, by the University, and by a number of private donors, and the result is a collection of sixty-nine reproductions which are unsurpassed among astronomical publications.

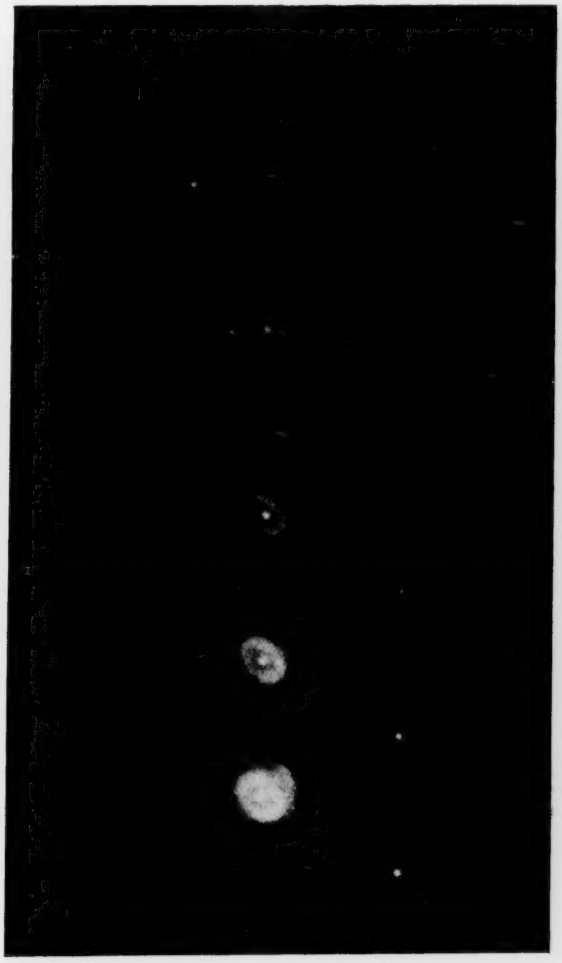
Professor Keeler's photographs, as is recorded by a note in the preface, enabled him to make two discoveries of prime importance—that many thousands of unrecorded nebulæ exist in the sky, in number amounting,

The Spiral Nebula H. I. 55 Pegasi. Exposure 2 minutes.

as subsequent investigation has shown, to about half a million; and that most of these nebulæ have a spiral structure. The photographs of the one hundred and four subjects which Professor Keeler selected for photography contained the images of 744 nebulæ not previously observed. A catalogue of these is published in the volume under notice. Their positions, which are thought to be accurate within 1″, were determined by Messrs. Palmer, Curtiss, and Albrecht. The photographs of sixty-eight of the larger and more interesting nebulæ and clusters on the programme are reproduced. The remaining thirty-eight are said to be either small or of less interest. The nebulæ exhibit all gradations of apparent size from the great nebula in Andromeda down to an object which is hardly distinguishable from a faint star disc.

To his principal conclusions Professor Keeler added another which is given significance by the photographs.

Among the objects which were photographed with the Crossley Reflector were most of the double nebulæ figured in the Herschel catalogue. The actual nebulæ as photographed had almost no resemblance to the figures (which had been drawn from ocular observations). They are, in fact, spirals, sometimes of a very beautiful and complex structure, and in any one of the nebulæ the secondary nucleus of Herschel's figure is either a part of the spiral approaching the main nucleus in brightness, or it cannot be identified with any real part of the object. The significance of this rather destructive conclusion lies in the fact that these figures of Herschel have sometimes been regarded as furnishing analogies for the figures which Poincaré had mathematically found to be the possible forms assumed by a rotating fluid mass. In other words, they had been regarded as illustrating in the sky an early stage in the development of double star systems. The actual conditions of motion are shown by the photographs to be much more complicated than that.

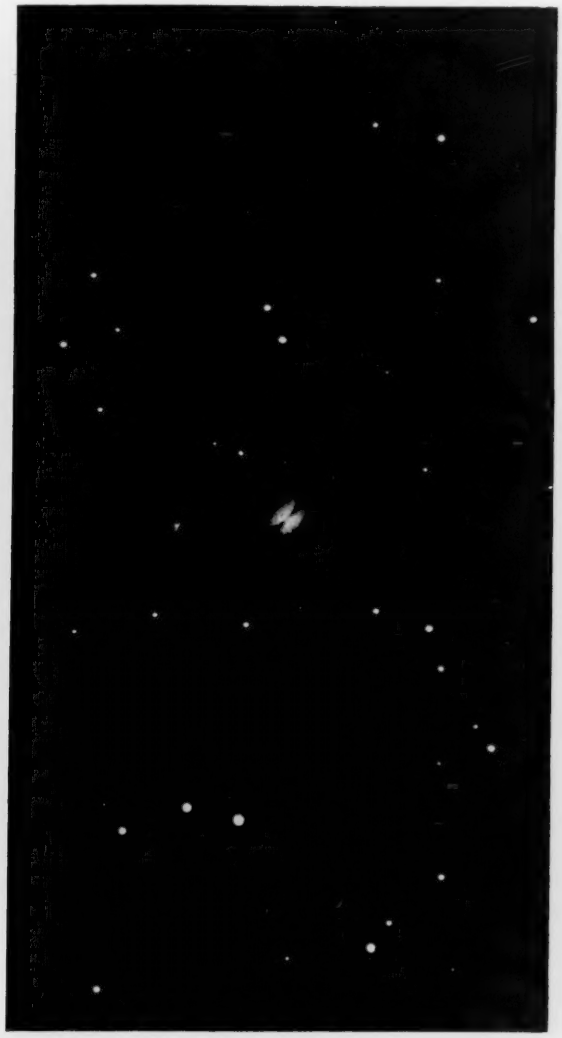


The Planetary Nebula H. IV. 18 Andromedae.

The photographs we reproduce are the last four in the volume.

There are five exposures of one object on this plate which disclose a brightness and distinctness varying with the times of exposure, which were 10 secs., 20 secs., 30 secs., 1 min., and 2 mins. respectively.

Though these are all apparently small objects, or, at any rate, smaller than some of the conspicuous nebulæ of the sky, they display very well the varying types of those nebulæ which have an orderly form.



The Nebula H. II. 240 Pegasi. Exposure 3 minutes.

Long-Distance Sterilization.

A METHOD of sterilizing milk or other liquids without using heat, and without contact with the sterilizing agent, has been patented in France. The inventor, Armand Billon-Daguerre, proposes to use the bactericidal properties of ultra-violet radiation, or of *x*-rays, for the purpose. His plan is thus described in *Cosmos*:

> "This method has the advantage of doing its work without heat and at a distance. For instance, the inventor has obtained good results by causing the milk to flow slowly over a slightly inclined plate of glass, the rays being emitted by an arc-lamp, placed above the plate, and using special electrodes giving only violet light; or by placing the milk in violet glass vessels of special tint and then exposing it to white light."

XUM

A Vegetable Furnace.

By DR. ALFRED GRADENWITZ.

PROFESSOR HANS MOLISCH, of Prague, has succeeded in showing a certain amount of spontaneous heating in leaves, showing their respiration to be far more intense than had so far been supposed. Recently plucked leaves, in a condition as dry as possible, were filled up in compact layers in wickerwork baskets, provided on the top with a pasteboard lid, perforated in its middle for the insertion of a long and sensitive thermometer. The basket having been placed in a wooden case, the space between it and the case was filled up with wood wool, so as to avoid as far as possible any loss of heat. When the case had been closed, the thermometer protruded sufficiently to allow temperatures to be read without removing it. In order further to reduce heat conduction and radiation the whole was wrapped in layers of cloth. As soon as the leaves had reached their highest temperature the investigator ascertained

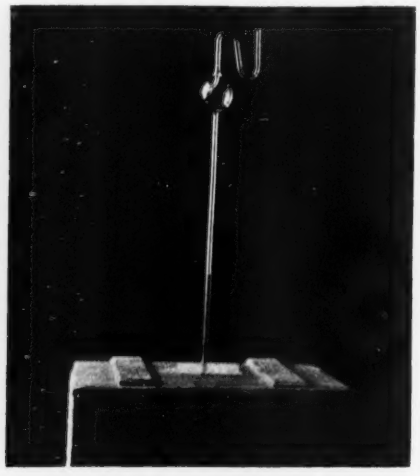


Fig. 1.—A Vegetable Furnace.
Arrangement of the ether tube in the box of respiring leaves.

whether they were still alive, after which the test was continued, and concluded with a search for micro-organisms (bacteria and fungi).

The first experiment showed that the leaves became heated in a very short time (9 hours) from 22° to about 44° C., and within 15 hours to 51.5° (125° F.). During the following 37 hours a slow drop in temperature to 34° C. was observed, after which the thermometer again rose to a somewhat lower maximum (47° C.), thenceforward falling definitely and finally.

The considerable rise in temperature observed during the first 15 hours, so far from being due to the action of micro-organisms, can only be ascribed to chemical re-actions and especially to *respiration*. At 43° C. the leaves were still alive, and when placed on water would remain fresh and green for some days. With 51.5° C. the maximum of spontaneous heating was reached after 15 hours. The subsequent drop in temperature is quite comprehensible because the leaves, being burnt at the temperature mentioned, normal respiration had to come to a standstill, while only slight amounts of bacteria were as yet present. However, those micro-organisms, protected by the high temperature, now began to thrive and rapidly to multiply on the dead leaves; the heat produced by their intense respiration resulted in a second maximum of temperature somewhat lower than the former (47° C.) being produced. After the evolution of bacteria and other fungi had thus culminated, the temperature slowly dropped to that of the surrounding air.

Similar results were obtained in connection with the leaves of a number of plants, maximum temperatures of up to 60° C. being reached. Certain plants, especially evergreens and those which, when severed from the mother plant, retain a remarkable durability, were found only to produce slight amounts of heat.

A remarkable demonstration test on the production of spontaneous heating is represented in Fig. 1. The apparatus will raise ether to boiling temperature merely by the heat of leaves, and thus actually constitutes a *vegetable furnace*. A glass tube three feet in length, closed at the bottom and blown up bulb-like on the top, is filled to one-third of its length with coloured ether and introduced by its closed end into a mass of leaves the temperature of which is intermediary between 45° and 50° C. (113-122° F.) or even higher. As the boiling temperature of ether lies at 34.5° C., it immediately begins to boil, as can be distinctly shown even before a large audience.

When the leaves are kept below water they are found to be killed at a far lower temperature than in air. The upper temperature-limit of life thus drops considerably as respiration is interfered with. The wound produced by plucking the leaves doubtless favours spontaneous heating, though the fact that twigs full of leaves tied up in considerable quantities likewise produce high temperatures strikingly shows that the wound stimulus is not the paramount factor. The spontaneous heating of leaves to the upper temperature-limit of life affords evidence of the curious fact that organisms can be killed by a normal function, such as respiration.

Sea Water Serum.

IT may be remembered that some years ago M. Quinton, a French physiologist, wrote a paper to show that the colourless fluid in which the red corpuscles of our blood float, and which is called the "blood serum" is the same fluid as that which constituted the primeval sea. The earliest forms of life which floated in the primeval sea were such that the cells and tissues of which they were constituted were always bathed by this primeval fluid. When silica became a constituent of the sea, these animals may have coated themselves with silicious coverings—but many of their cells were still bathed by the fluid—and some of them as they passed from the sea to the land may have closed up their alimentary canals, so that a distinction arose between their internal organs and their outer superfices—but still, for the good of their cells they still bathed them in the saline fluid. To do so more effectively they took the saline fluid ashore with them in the form of a blood serum; and it is this blood serum which we carry about with us to-day, the most evident relic of the age when we were marine animals. Such is Quinton's hypothesis, and a practical application for it has been recently found in France and America. Quinton found that in pure sea water the leucocytes, or white blood corpuscles, of man and of a number of other mammals and reptiles would continue to live. The experiment has suggested that the injection of pure sea water into the veins might in some instances serve as a useful tonic; and though its uses are distinctly limited there are certain conditions in which it has been found useful.

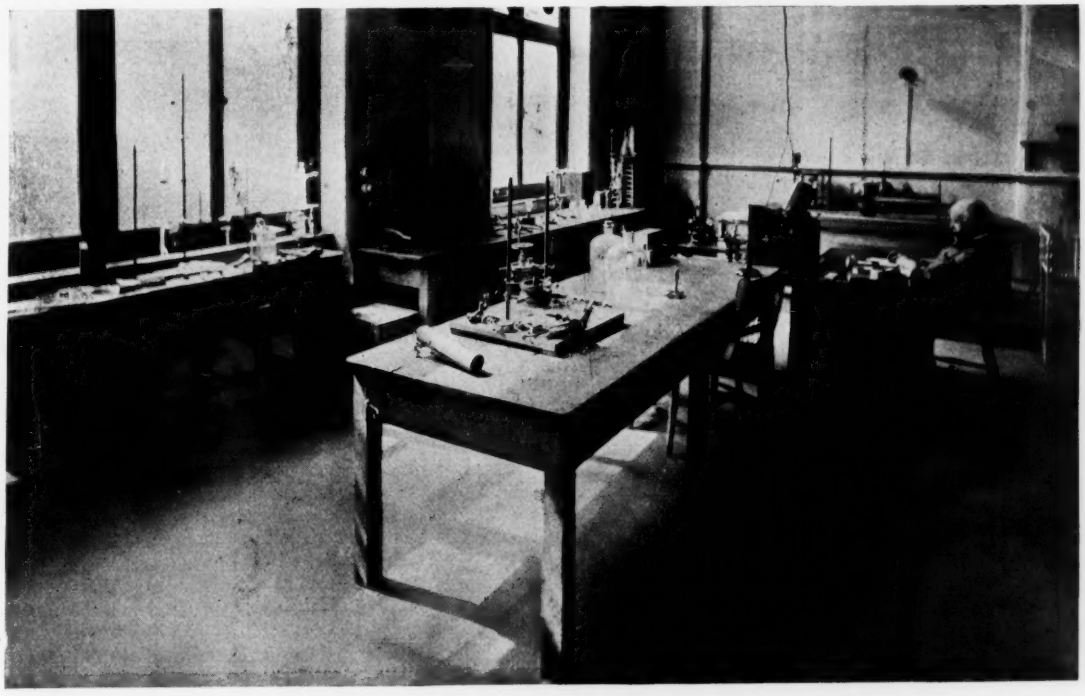
XUM

University College Physiological Laboratories.

A NEW Institute of Physiology, which is certain to be of great importance both to teaching and to research, was opened by Mr. Haldane at University College, Gower Street, during the month of June. The provision for research made in these laboratories is of a double interest. Since the incorporation of University College with London University a purposeful and well-organised effort has been made to make it worthy of a modern University, not only as a theatre of instruction, but as a centre of independent inquiry. There are two ways in which the widely scattered University of London may develop. It may be split up into a number of different faculties in different localities, so that, for example, all the Botanical Schools may be gathered in one place—an Institute of Botany at Kew would be the ideal place and locality—all the medical sciences, such as Physiology, Pharmacology, Anatomy, at another; Physics and Chemistry at the Royal College of Science; Geology and Mineralogy also at South Kensington—and so on. Alternatively all the teaching centres of the University might be grouped in the neighbourhood of the great terminal railway stations. This method, though less scientifically attractive, has the practical advantage of affording convenience of access to the increasingly large number of students and teachers who live outside the omnibus radius. Whichever scheme may prove the more adaptable in the future, University College has shown great vigour and ability in re-forming itself in all its faculties so as to adapt itself to modern needs, and in no department has the new spirit been more evident than in the Physiological Laboratories, of which Dr. E. H. Starling, F.R.S., is Director and Jodrell Professor.

Operating room for animals.

These laboratories will ultimately be flanked by others which will be devoted to the study of Anatomy and Pharmacology, thus completing an Institute of Medi-



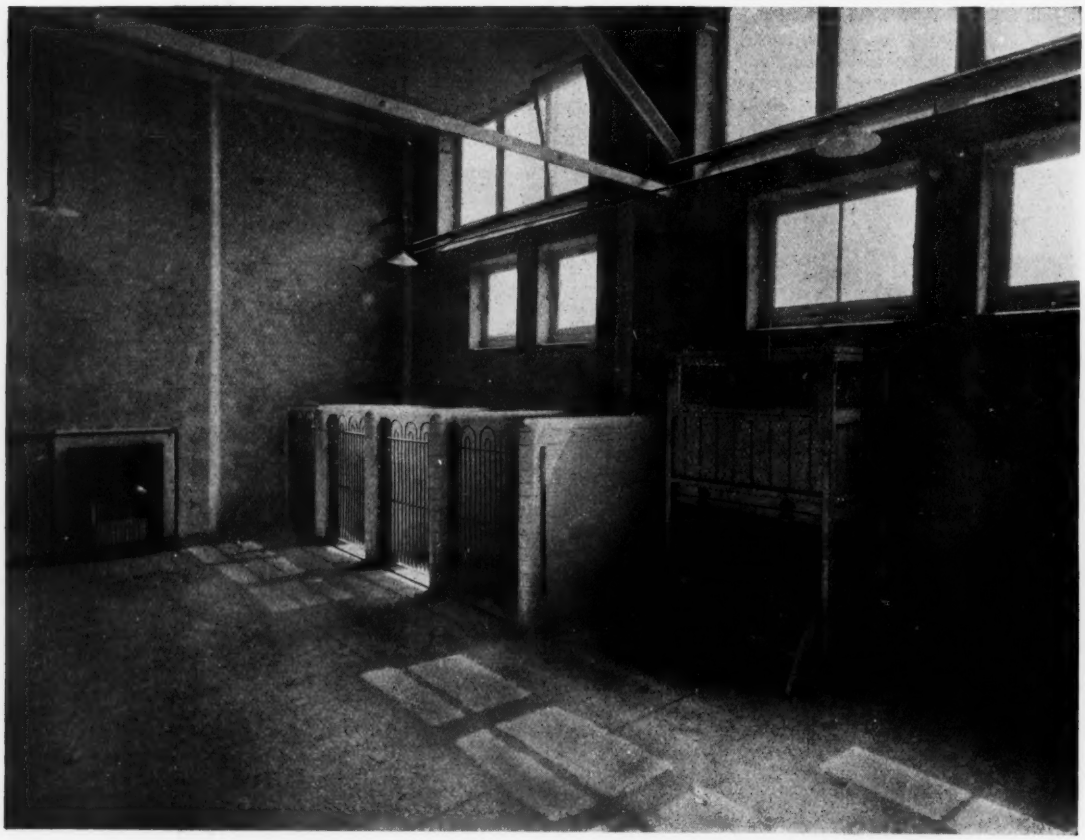
Laboratory for Physiological Measurements (Dr. Bayliss).

XUM

cal Research; and this future has been kept in view both in the exterior and the interior of the new building. Its exterior, though architecturally pleasing because of its simplicity and its evident suitability to its purpose, has little or no embellishment. There will be time for that when it is completed by the projected additions. It is not less simple and economical inside than outside. The building has three floors above a basement, and each floor consists of two large rooms of sixty by forty feet, as brilliantly lighted by large windows as the Building Acts permit, and divided or divisible into small rooms by Mack partitions. Thus at any future time the whole building can be re-arranged at very small expense. At present the basement contains such rooms and appliances as are needed or utilised by all the departments of the floor above, such as a refrigerating chamber and an incubator chamber, both of which can be used for preserving or developing physiological specimens, the boiler and machinery rooms, dark rooms for photography, and a destructor furnace. Above the basement the ground floor is entirely devoted to physiological chemistry, the first floor to experimental physiology, and the top floor to the departments of histology, neurology, and the aseptic department.

The department of physiological chemistry has the largest students' laboratory, sixty feet by forty feet, and affording accommodation for a hundred students. There are other laboratories for the use of the professors and for general research work, as well as smaller rooms for special forms of experiment. This department is under the charge of Dr. Aders Plimmer, to whose generosity the Institute is indebted for a very handsome

Where the animals are kept.



Animals' Hospital.

gift to the funds which have made its construction possible.

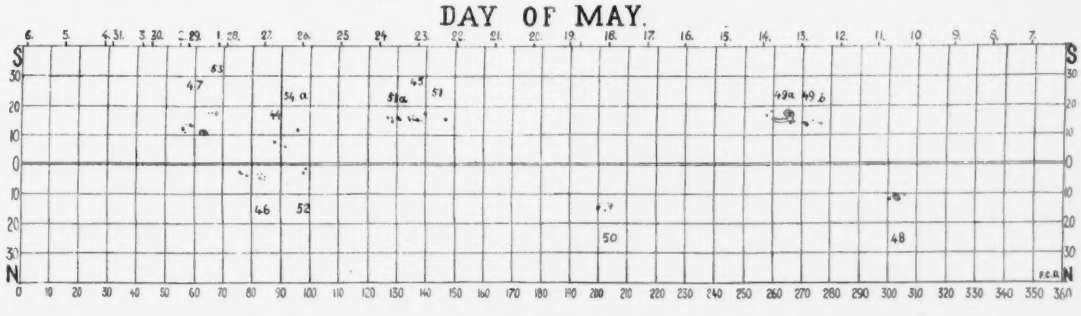
The departments of experimental physiology, under the direction of Drs. Starling and Bayliss, are those which are most original in design, and which embody an advance of considerable importance to physiology. In order that the experiments which are made on animals should be of the highest instructive value by affording trustworthy comparisons with conditions in the human subject to be made, it is necessary that the animals should be in normal health ; that they should not suffer pain—because, as Professor S. H. Starling has pointed out, there is nothing which causes functional disturbance more readily than pain ; and that operations conducted on them should be made under the same careful aseptic conditions as those accompanying surgical operations in hospitals. Thus the operating rooms, and the anæsthetising chambers are identical with those constructed according to the modern teachings of aseptic surgery ; and alike in the animals' sheds, and in the animals' hospital, the most elaborate provisions are made for keeping the animals in health and comfort. In all other respects the Laboratories are representative of the most modern ideas, and a future at once solid and brilliant for them is assured under the guidance of Professor Starling, who has been the moving spirit in their design and structure, of Dr. Bayliss, Dr. Aders Plimmer, and Dr. Page May.

Solar Disturbances During May, 1909.

By F. C. DENNETT.

DURING May the number of disturbances have decreased, but one has been of a very intense character. The central meridian at noon on May 1 was longitude 67° 53′.

Nos. 44, 45, 46, and 47, remaining on the disc until May 5, 2, 6, and 7 respectively, re-appear on the present chart.



No. 48.—When seen on 5th and 6th two spots; on 7th a spot 11,000 miles in diameter with a pore closely south, and three others east; slight changes each day until 10th; on 11th pores were east, west, and south, these changed from day to day; and on 13th the large spot was 16,000 miles across. A triangle of spotlets on 15th, one only after until 17th.

Nos. 49 and 49*a*.—Heralded by a brilliant group of metallic prominences on 6th, a spot, 15,000 miles in diameter, with a triangle of spots south-east, had come round on 7th. The triangle, *a*, had developed a great deal of penumbra by 8th, and soon grew to a spot 30,000 miles across, visible to the naked eye. Trails of spotlets opened, so that by 11th a great pot-hook formed outbreak was formed with the large spot in the centre. By 13th the group *a* formed a markedly cyclonic disturbance which, during its passage over the central meridian, was accompanied by a fine auroral display and a considerable magnetic disturbance. After 17th the group dwindled, being last seen, 49 on 19th, and *a* on 20th. A great eruption occurred in the group *a* on 8th, hydrogen being projected to a height of over 150,000 miles.

No. 49*b*.—A group of spotlets formed west of 49 and remained visible until 17th, increasing the length of the outbreak, which, in all, totalled 130,000 miles. 14-17th.

No. 50.—An elliptical disturbance 22,000 miles in greatest diameter on 18th, which doubled its length by 20th, and was last seen 21st.

No. 51.—Two pores in a faculic bed 17th to 20th; the leading one only a gray marking on 21st. On 22nd the following pore had two tiny companions south-west, but only the one pore when last seen on 23rd. The length of the disturbance 51,000 miles.

No. 51*a*.—Only two pores on 20th, but on 21st developed the elliptical characteristic noticeable in so many outbreaks. Its length reached 80,000 miles, one of its members on 24th being 10,000 miles in diameter. From this date it decreased, so that only one pore was visible on 29th.

No. 52.—A pore in faculic surroundings 20th and 21st, with a tiny companion south-south-west, which increased in visibility during observation on 22nd, but all was gone on 23rd.

No. 53.—A spot some 10,000 miles in diameter alone 22nd to 28th, but with two pores east 29th to 30th; again solitary 31st. Only a grayish pore on June 1st and 2nd when last seen.

No. 54.—Two pores only seen on 27th and 28th, 22,000 miles apart, the following one close to the place of No. 44.

No. 54*a*.—A solitary pore, a little south-west, only seen on 29th.

The observers from whose observations our chart has been constructed were Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

XUM

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Seventh International Congress of Applied Chemistry.

The ninth section of this Congress dealt with Photo-chemistry and Photography, and its meetings were well attended by both English and foreign members. The thirty or so papers that were read dealt with many subjects that were duly discussed. I may, perhaps, select two communications as of particularly fundamental importance and originality.

The Developable Image.

Dr. Lüppo-Cramer has found that a developable image produced by Röntgen rays may be "developed" or made visible by merely exposing the plate to light, whether daylight or light from any ordinary artificial source. Those parts acted on by Röntgen rays become green at the same time that the rest of the plate becomes red. This effect was demonstrated at the meeting. This proves that the same treatment produces different effects upon developable images produced by different means, and appears, therefore, on the face of it to demonstrate that the developable image is not always of the same kind, and, therefore, does not always consist of silver bromide that has lost an unrecognisably minute quantity of bromine. Hypotheses concerning the nature of the developable image generally seem to include the notion that a developable image is always of the same general character. Much evidence points in the opposite direction, and this experiment of Dr. Lüppo-Cramer's is a valuable addition to it. Doubtless a developable image may result from a chemical change, but I still hold to the idea that this is not a sufficient explanation, and that the known facts concerning the developable image as generally produced indicate that the silver bromide is changed but not decomposed.

The Eder Solution.

This is a solution containing mercuric chloride and ammonium oxalate, which is decomposed by exposure to light with the production of a white precipitate of mercurous chloride. It was introduced by Dr. Eder for actinometric purposes, the quantity of mercurous chloride formed being taken as the measure of the actinic power of the light acting upon it. It has been shown that this solution varies considerably in sensitiveness, and Dr. Chr. Winther communicated to the Congress the results of his investigation of the matter. He concludes that the pure solution, quite free from iron, is insensitive to light, and that whatever measure of sensitiveness it possesses is due to the presence of iron salts. Granting this, it is obvious that various samples of the two salts are certain to vary in the quantity of the minute trace of iron present in them, and this variation was actually found, some preparations being as much as three times as sensitive as others. If the amount of iron present is varied by adding more as necessary, an enormous variation in sensitiveness may be produced; the author estimates the range as up to about twelve thousand times the sensitiveness of the least sensitive solution. It appears that ferric oxalate is the really sensitive substance in the solution, but in the absence of air or oxygen the resulting ferrous oxalate will precipitate up to about four thousand times its equivalent amount of mercurous chloride. The ferric oxalate being reduced by light to ferrous oxalate and carbon dioxide, the ferrous oxalate at once reduces the mercury salt to mercurous chloride, ferric oxalate being reformed. And so the cycle of changes goes on as long as the light acts. Without having regard to the iron salt and the gaseous oxygen (air) present, the Eder solution is useless for actinometric purposes, but by regulating these it may be possible to get a measure of uniformity.

Lantern Screens.

As lantern slides made on "colour-screen" plates become more common there is a growing necessity to provide for their exhibition. Under the best theoretical conditions the light such a slide can transmit is only one-third of that transmitted by an ordinary slide or a colour slide made by the Sanger-Shepherd process, and in the autochrome plates it is less than half this, because of the opalescence of the film, due chiefly, perhaps, to the starch grains. To overcome this difficulty the light may be increased, say, ten times, but this is not possible with all illuminants, and if possible it means a corresponding increase in the heat produced. The most ready method is to reduce the magnification; but it may not always be satisfactory to give, say, a three-foot disc on the sheet instead of an eight-foot disc, and it may not be practicable to get the lantern near enough to the screen to get the smaller disc. The one remaining method of improving matters is to increase the reflecting power of the screen. This can be done by the use of a metal surface, as was done by Anderton nearly twenty years ago, giving up a measure of diffusion for a proportion of regular reflection. This gives a brighter picture to those centrally opposite the screen, but the brightness falls off as one moves sideways very much more rapidly than when the image is projected on to the usual whitewashed surface. To obviate this disadvantage one is naturally lead to desire a room of a more oblong shape than is usual, or, at least, to arrange the spectators so that those generally at the sides are moved to the back that they may be more nearly in the line of direct reflection. Some interesting figures as to brightness and angles in connection with various metallic-surfaced and other screens are given in an article by Drs. Lehmann and von Hübl in the last Colour Supplement of the British Journal of Photography.

"Radiations" from Metals.

According to E. B. Andersen (*Science Abstracts*, 1909, 156), photographic plates differ in their sensitiveness to the action of metals, some, indeed, being insensitive. The more electropositive metals (magnesium, aluminium, zinc, cadmium) must have polished surfaces, while the electronegative metals must have mat surfaces. The result is associated with oxidation, and shows "a diffuse radiation of very feeble penetrating power, capable of reflection and of converting oxygen into ozone," which, of course, can produce its own characteristic effects. If the oxidation of the metal produces "rays" *and* a gaseous reagent, a condition of affairs that appears to be very probable, then those that have regarded the effect on the plate as due to a diffusable gaseous body and those that have ascribed it to "rays" may both be correct in the deductions from their experiments, except so far as they have found the one or the other to be the only product of the action.

A SYSTEM of wireless telephony was recently tested by the French Navy between the armoured cruiser *Condé* and shore stations. It is reported that conversation was carried on over a distance of 100 miles. The inventors of this system are Lieutenants Jeance and Colin of the French Navy. Their work is quite remarkable in view of the fact that in our own Navy we have had difficulty in maintaining wireless telephone communication over a distance of 20 miles.

An Alarum Sun-Dial.

By CHARLES E. BENHAM.

THE Franklin Tube, sometimes called the "pulse glass," which can be obtained from the instrument maker for about a shilling, is a differential thermometer of a very sensitive character. The principle of the instrument involves the confinement of water that has been boiled for some time in a glass tube, which is then hermetically sealed, the tube consisting of two bulbs set at right angles with a connecting tube as shown at A B (Fig. 1). There being little but water vapour in the open space of the bulbs, it suffices to apply the gentlest warmth, as that of the hand, to either bulb, and the liquid is promptly driven into the other and at the same time brought to ebullition, owing to the absence of appreciable air pressure. If the warmth is equally applied to both bulbs simultaneously no effect is produced. Taking such a tube, preferably with elongated bulbs, and mounting it on an axis, see-saw fashion, as shown in Fig. 1, it is clear that any difference in temperature between the two bulbs will cause a flow of the

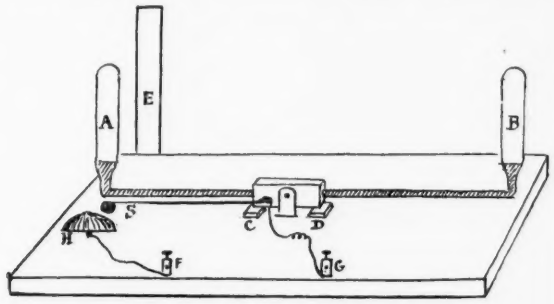


Fig. 1.

liquid towards the cooler one, and the descent of that end by the gravity of the added fluid. In this way, the Franklin Tube may be easily converted into a sunlight motor. All that is necessary is to coat the bulbs with lamp-black (stirred into methylated spirit with a little French polish as fixative) and to arrange screens so that the lower bulb on either side is always in the sunshine, and the upper bulb is always shaded by the screen. Whichever bulb is uppermost will thus continually have the liquid driven into it from the warmer lower one, and will descend by its increased weight into the sunlight, to become in turn the warmer and drive the water into the other bulb, and so the tube will be kept in periodic oscillation. The stops C and D can be placed at any convenient position under the rocking tube. The force, though small, might theoretically be made considerable, for the principle could be equally applied to tanks of a large size, though, of course, in such case, the great capacity for heat that water possesses would render the cooling somewhat slower, and the alternate movements would not succeed each other with quite the promptness of response given by a smaller instrument.

Apart from using solar heat, which is an uncertain quantity in this climate, the principle suggested indicates a clue to the construction of a motor which might be applicable in special cases and in which great economy of heat might be effected, for it must be remembered that in the ordinary steam engine an enormous amount of heat is so to speak wasted in the preliminary essential of overcoming the atmospheric pressure.

The application of the motive power to be here described is a simple device by which when the sun shines the balanced Franklin Tube may be made to ring a bell at twelve o'clock, and by means of an equally simple electric attachment to give a signal at a distance at the same time, ringing an electric bell or firing a gun by the electric charge.

These effects are accomplished by allowing the descent of the bulb A to cause the hammer S, which is a thin spring attached to the metalwork near the axis and having a knob at the other end, to strike the bell H, which is just out of reach of the clapper even at its lowest, except when the sudden descent of the lever causes the spring momentarily to vibrate. To make this occur at the hour of noon it is only necessary to fix the upright metal strip E so that it is due south of the bulb A and therefore shadows it at the hour of twelve. There is no need to slope the gnomon as in the dial, as for twelve o'clock a straight rod answers just as well if made long enough to allow for the short shadows of the summer noon. The original adjustment of the position of the instrument on a clear south window-sill may be made by experiment, and it will be found that the shadow need only creep over about one-half of the bulb A to produce the required difference of temperature. Two light wires from the bell and the central attachment of the hammer respectively will not interfere with the movement, and may be led to the two binding screw terminals F and G for connecting up with a battery, &c. The bell itself thus becomes a switch for an electric circuit, which can of course be carried to any distance and made to ring an electric bell or give any other form of warning that can be produced by an electric current.

It is not to be supposed that an instrument of such extreme simplicity will work with the accuracy that might be required for scientific purposes, but, due allowance being of course made for the daily difference between sun and clock time (as with the ordinary sun-dial), it will be found remarkably regular if suitably placed. The instrument is so very sensitive that it will be entirely unreliable unless protected from draughts. It should be enclosed in a glass box considerably larger than itself, so as to avoid screening by the uprights of the case. A strip of tinfoil on the front glass will then serve for the gnomon. Air holes are allowable in the glass case if lightly plugged with cotton wool to avoid strong air currents.

For greater accuracy it would be advisable to construct the bulbs A and B still longer and narrower and to enclose the whole instrument in a metal case, light-tight except for a narrow slit faced with metal plates placed north and south for the bulb B, while a similar slit at a slightly different angle would let the sunlight fall a few minutes later on A, and so reset the instrument automatically. It can of course be easily reset by hand. There is no reason why such an arrangement, carefully made, should fail to give a high degree of accuracy. The varying power of sunlight at different times seems an obstacle, but it must be remembered that it is on the difference in temperature of the two bulbs rather than on the actual temperature of them that the action of the instrument depends.

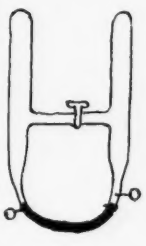


Fig. 2.

The same effects may be prettily produced with an ordinary differential thermometer containing a thread of mercury instead of the usual column of spirit, and with platinum terminals penetrating the tube in such positions that when the shadow cools one of the bulbs the mercury closes the circuit of an electric bell,

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but this from of instrument, outlined in Fig. 2, though it is very sensitive, is rather more difficult of construction, and the continual action of thecurrent seems to have a tendency to oxidise the mercury after a time. This difficulty could however, be minimised and practicallly abolished by instituting a relay and using a very small current.

Naked-Eye Observations of the Planet Mercury.

By IRENE E. TOYE WARNER.

MOST amateur astronomers find great pleasure in observing the planet Mercury with the unaided eye. Patience, caution, and keen vision seem to be the chief requisites in this interesting occupation—patience, because the western horizon is rarely free from cloud or mist in this country, and the slightest haze is sufficient to veil Mercury's sparkling lustre; caution, because great care should be taken not to mistake a fixed star for the planet; and a keen eye to detect him in the strong twilight or dawn when he is at his elongations east or west of the solar orb.

It is not often that we have such an excellent opportunity of observing the smallest of the primary planets as has been afforded this last May apparition. The western sky has been free from clouds, or nearly so, and I have, therefore, seen Mercury with the unaided eye on no less than *fourteen* evenings; this is fairly good in this uncertain climate.

Mr. W. F. Denning, F.R.A.S., noticed the planet on thirteen occasions in May, 1876, and between April 22 and May 11, 1890, he succeeded on ten evenings. Mr. W. F. Gale, F.R.A.S., says that in New South Wales he has seen Mercury on 34 consecutive nights commencing on June 28, 1906—one night, July 18, alone excepted; this fact speaks well for the Australian climate.

My own observations for the May elongation this year began on the 8th at 8h. 30m., when the planet appeared as brilliant as Jupiter and shone with a steady, deep yellow light very like that of the "Giant Planet." Mercury was at greatest distance east of the sun on May 20, and after that date his lustre steadily declined until, when last seen, on the 25th, an opera glass had to be used to find him, after which he could be easily held with the naked eye.

When his phase became more crescented, after elongation, the sparkling quality for which he is noted was more apparent, the colour varying from deep yellow to pale primrose, with frequent flashes of rose pink. The best time to observe Mercury is for about ten evenings *before* the date of greatest east elongation during the apparitions which occur in the first half of the year, and for the same time *after* west elongation in the last half. When at east elongation he should be seen in the western sky about an hour after sunset, and at west elongation the same time before sunrise, near the eastern horizon. When at greatest elongation viewed telescopically, he appears like the half-moon; when in superior conjunction with the sun he becomes round, being then fully illuminated; and when near inferior conjunction a thin crescent, being at that time between us and the sun, in the same way as our satellite when new.

Most astronomical books speak so despondingly of the many difficulties of seeing Mercury in this country that it would, perhaps, be interesting to know the record for observations made *at one elongation*. I have only looked for the planet during the last three years, but have seen him on 33 occasions as an evening star.

The Origin of Meteorites.

PROFESSOR WILLIAM H. PICKERING, of Harvard Observatory, contributes to *Popular Astronomy* a paper on the origin of meteorites. He distinguishes between the two types of meteorites, those that are composed chiefly of iron, and those composed chiefly of stone. "By the term meteorite as distinguished from meteor, we refer to those bodies that actually strike the earth's surface. Meteorites are usually divided into two classes, those composed chiefly of iron, and those composed chiefly of stone. Of the 292 actually observed meteoric falls that took place during the last century, only 12, or about 4 per cent., belonged to the first class, yet in our cabinets the two classes are represented in nearly equal numbers. The explanation of this strange anomaly lies in the fact that unless the fall has been actually witnessed close at hand, very few of the stony meteorites are ever found. Of 328 in the collection of the British Museum, 305, or 93 per cent., were seen to fall. This is partly because these bodies to ordinary inspection appear very like common stones, and therefore are not recognised as meteorites, and partly because owing to their physical and chemical structure they are readily decomposed by the action of the elements."

It has been suggested that if meteorites were formerly much more common than at the present day, we should find their remains in the earlier geological strata. This does not necessarily follow, however, and it is probable that, owing to disintegration and decomposition, we should not now be able to recognise them as such, or distinguish them from the earlier basaltic lavas with which they are closely allied, both in chemical and in mineralogical composition. Beneath the sea, however, they have been preserved, and it is clear that in former times they must have been very numerous, for in the abysmal depths, where little recent sedimentary matter occurs, their remains are frequently found. Geikie, in his Text-Book of Geology, page 584, writing of this region, says: "In these deposits, moreover, occur numerous minute spherular particles of metallic iron and 'chondres' or spherical internally radiated particles referred to bronzite, which are in all probability of cosmic origin—portions of the dust of meteorites which in the course of ages have fallen upon the sea-bottom."

It is the almost universal custom to associate meteorites with falling stars, and to say, therefore, that they are of cometary origin. This relationship, however, is not as obvious, when we begin to examine into the case, as it at first sight appears. A prominent difficulty is that the distribution of the meteorites throughout the year differs very materially from that of the falling stars and fireballs. While these last two are about twice as numerous during the latter half of the year as during the first half, the meteorites are more numerous during the first half of the year. From this we should infer that, while perhaps all meteorites are fireballs, only comparatively few fireballs became meteorites. The dividing line between meteorites and falling stars then lies among the fireballs, the swiftly moving ones being allied to the falling stars, and the slowly moving ones to the meteorites.

It is now generally accepted that the crystalline and often conglomerate structure of these bodies proves them to be but the fragments of much larger bodies that have in some manner been destroyed, or from which they have otherwise become separated. Many believe that the crystalline structure of the iron meteorites indicates a slow cooling, while some say that the structure of the chondres of the stony meteorites must certainly have

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been produced by a very rapid crystallisation due to a sudden exposure to a lower temperature.

Professor Pickering dismisses the idea that meteorites were of volcanic origin, and were projected either from lunar or terrestrial volcanoes. Such fragments would have had to leave the earth at a speed of seven miles a second or the moon at a speed of two miles a second; and it is improbable that either lunar or terrestrial volcanoes ever commanded such explosive energy. Professor Chamberlin pointed out in 1901 that the too near approach to one another of planetary bodies would result in the case of a small planet in its disruption owing to the tearing off of its surface strata and the release of the explosive energies below. As an extension of this principle Professor Pickering examines the hypothetical case of the influence of the earth and the moon on one another at the time when, as postulated by Sir G. H. Darwin, the moon separated from the earth.

"When the truly enormous pressure on the deep-lying terrestrial strata was suddenly relieved by the departure of the upper layers, which now form our moon, tremendous explosive energy must have been generated. Considerable portions of our atmosphere must have followed the larger flying masses, and the atmospheric resistance to the smaller ones, swept along at the same time, would have been much diminished. Although we can probably never definitely know just what occurred at this time, it is quite possible that considerable quantities of the smaller masses were carried along by the blast of escaping gases, and were projected to such distances as to entirely free themselves from the attraction of our planet. This implies a solid crust for the earth at the date of birth of the moon, which previous investigations of the place of origin of that body seem to justify.

"In order to fix our minds, let us assume that at the time of the removal of this matter from the earth's surface, one-tenth of 1 per cent. of it was projected with a more or less parabolic velocity into space. If concentrated into one piece, this would have formed a sphere of the density of the moon, and 200 miles in diameter. Let us suppose, however, that instead of forming only one piece it was really concentrated into a great number of little moonlets, to adopt a term suggested by Professor G. K. Gilbert, varying from a few miles in diameter downward.

"Those moonlets whose velocities were only elliptic, and whose courses at the start were so perturbed that they did not at once return to the earth, would continue to revolve about the centre of gravity of the earth and moon, which in those days were close together. Generally they would move in very eccentric orbits. Those moonlets whose velocities were hyperbolic would free themselves from our planet, but still could not escape the sun, and would therefore revolve about it in orbits coinciding more or less closely with that of the earth.

"Since all the moonlets that we are now considering were moving with velocities approximately parabolic with regard to the earth, and since they would be constantly meeting both that body and the moon, their orbits would be subject to most violent perturbations constantly shifting them back and forth between hyperbolic and elliptic conditions. Moreover, they would all of them sooner or later pass near enough to one or the other of the two large bodies to be minutely fractured by it, in the manner so fully explained by Professor Chamberlin in the paper above mentioned. It is suggested that all the stony meteorites, and perhaps also some of the metallic ones, were formed in this manner.

"In support of this view of their terrestrial origin we have the fact that 29 terrestrial elements, including helium, have so far been recognised in meteorites, 10 of them being non-metallic. No new elements have been found. The six which occur most frequently in the earth's crust, named in the order of their abundance, are oxygen, silicon, aluminum, iron, calcium, and magnesium. The eight most commonly found in the stony meteorites are these six, besides nickel and sulphur.

"Nearly all the stony meteorites contain some metallic iron, and some of them contain large quantities of it. But this is also true of some of our basaltic lavas. Indeed, large masses of iron have been found in ledges upon the Greenland coast. Some of this iron contains over 6 per cent. of nickel, but much larger proportions have been discovered in New Zealand, Piedmont, and Oregon, where considerable quantities of the nickel iron alloys have been found. According to Farrington, of the 21 minerals recognised in meteorites, 14 have been found in our volcanic products."

On the other hand quartz, one of our most common minerals, has not hitherto been detected in meteorites. It has been shown by Sir John Murray, however, that when silicates are exposed to the action of carbonic acid for any length of time, the bases are changed to carbonates, and silica is set free. These favouring conditions have existed on a large scale in the case of the earth, but certainly do not exist on meteorites. This would accordingly seem to answer this objection. Another difficulty which has been raised to the terrestrial origin of meteorites is that over 90 per cent. of the stony ones contain chondres, and that these latter are never formed under terrestrial conditions. They are supposed to be due to rapid crystallisation in a suddenly cooled mass, and naturally these conditions could never occur within the earth's interior. If, however, the molten matter were suddenly expelled by a violent explosion into interplanetary space, we have the very conditions which are supposed to be required for their formation.

IN connection with the Darwin centenary, at Cambridge, the degree of doctor of science was conferred upon E. van Beneden, professor of zoology in the University of Liège; Robert Chodat, professor of botany in the University of Geneva; Francis Darwin, F.R.S., of Christ's College; Karl F. von Goebel, professor of botany in the University of Munich; L. von Graff, professor of zoology in the University of Gratz; H. Höffding, professor of philosophy in the University of Copenhagen; J. Loeb, professor of physiology in the University of California: E. Perrier, director of the Natural History Museum, Paris; G. A. Schwalbe, professor of anatomy in the University of Strassburg; H von Vöchting, professor of botany in the University of Tübingen; H. de Vries, professor of botany in the University of Amsterdam; C. D. Walcott, secretary of the Smithsonian Institution; E. B. Wilson, professor of zoology in Columbia University, and C. R. Zeiller, professor of paleobotany in the Ecole Nationale Supérieure des Mines, Paris.

MR. C. G. ABBOT, director of the Smithsonian Astrophysical Observatory, has left Washington for Mt. Wilson, California, to continue there during the summer and fall observations in progress for a number of years as to the intensity of the sun's rays and the effect of any variation in them upon the earth. There has recently been erected on Mt. Wilson a small permanent observatory especially designed for this purpose. Here Mr. Abbot, with the assistance of Dr. L. R. Ingersoll, of the University of Wisconsin, will study during the next few months. The expedition will also spend some time on the summit of Mt. Whitney, 14,500 feet high, where the Institution plans to erect in July a shelter of stone and steel for the use of scientific investigators engaged in researches of any kind for which high altitudes, dry air and clear skies are desirable.

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"Stones from Heaven."

The Veneration of Meteorites in Ancient Times.

By IRENE E. TOYE WARNER.

I.

Stones from Heaven! Can you wonder—
You who scrutinise the Earth,
At the love and veneration
They received before the birth
Of our scientific methods?

II.

Stones from Heaven! We can handle
Fragments fallen from realms of Space,
Oh! the marvel and the mystery
Could we understand their place
In the scheme of things created!

III.

Stones from Heaven! With a mighty
Comet whirling formed they part?
Fell they from their lofty station
Like a brilliant fiery dart,
Hurl'd from starry fields of Night?

IN ancient times, before the advent of strict scientific investigation, it is no wonder that stones which literally "fell from heaven" should become objects of great religious veneration on earth. A few of the most remarkable deserve special description, exercising as they did so much influence on important nations of antiquity.

We are told in the Book of Joshua that when the five kings of the Amorites fought against the great Hebrew general at Gibeon and were defeated, that as they fled at Beth-horon "the Lord cast down *great stones from heaven* upon them unto Azekah, and they died." In the same verse (Joshua x., 11) instead of "stones" we have "*hail-stones*," but according to Parkhurst's Hebrew Lexicon this is an incorrect translation, as the original word "abenim" means stones in general, and in Job xxviii., 3, the word is translated "stones of darkness." So the stones which fell at Azekah were probably aerolites such as have been several times recorded in ancient history.

Diana of the Ephesians.—There is good reason to suppose that "Diana of the Ephesians which fell down from Jupiter," and of whose popularity we have such a vivid description in Acts, was originally a meteoric stone, as was also the image of Venus at Cyprus. As the former is of peculiar interest to us we may give a few details illustrating the great veneration in which Diana was held by the people of Ephesus. We are told that a silversmith named Demetrius collected many others of the same trade together and pointed out to them that Paul, by his preaching against "gods made with hands," was rapidly taking away their trade which consisted of making silver shrines for Diana's image. Not only was Paul thus damaging them, but they also feared that the great Temple of Diana would soon be neglected and she herself "deposed from her magnificence, whom all Asia and the inhabited earth worshippeth." After this address, which was very much to the point, the silversmiths were filled with wrath and shouted "Great is Diana of the Ephesians." The whole city was thrown into confusion and Gaius and Aristarchus—Paul's companions—were seized, the Apostle narrowly escaping the same fate. The chief officers fortunately were friendly to him and so kept him from the fury of the populace.

"Some therefore cried one thing and some another, for the assembly was in confusion, and the more part knew not whereof they were come together." Alexander was then put forward to speak to the crowd, but they would not hear him, "all with one voice about the space of two hours crying Great is Diana of the Ephesians." He was at length allowed to speak after the town clerk had obtained a hearing for him, and he then told the people that the city of Ephesus was temple keeper of the great Diana and "of the image which fell down from Jupiter" (or 'heaven'); as no one could deny them this honour they should do nothing rash, but should prosecute Paul before the courts in the usual way. His words had the desired effect, and the angry multitude gradually melted away and Paul left the city.

The Temple of Diana was burned down in 356 B.C., and subsequent to that year the great building so famous in history was erected by the Ionians. It is thought to have taken 220 years to construct, and measured about 400 feet in length and 200 feet in width, containing 127 Ionic columns nearly 65 feet high. The columns were 7 feet in diameter, and were shaped from single blocks of marble; these enormous blocks were enclosed in wooden frames and rolled eight miles, from the quarries to the site of the temple, by order of the architects, Chersiphron and his son Metagenes.

Black Stone of Mecca.—Of all "heavenly stones," that of Mecca has commanded the most reverence. Its history goes back into the ages before the rise of Mohammed, who seeing that he could not prevent the Arabs venerating it, most wisely allowed them to continue, only substituting belief in the One God as supreme. The popular idea is that it is one of the precious stones of Paradise which fell down to the earth with Adam and, being taken up again at the Deluge, was afterwards brought back to Abraham by the angel Gabriel when he was building the Caaba or part of the Temple of Mecca. It is set in silver, and fixed in the south-east corner of the Caaba at a height of about "seven spans" from the ground. It is supposed to have originally been pure white, having long ago become black on the outside from the kisses of sinful men.

The Karmatians carried away the sacred stone and could not be persuaded to restore it for twenty-two years, after which, finding that the pilgrims still went to Mecca instead of following the stone, they sent it back, and it was restored to the Temple, where it has been ever since. In performing the religious ceremony of compassing the Caaba seven times, the "black stone" is either kissed or touched with the hand, which is afterwards kissed. The same veneration for this stone continues down to the present time, and is likely to last as long as the Mohammedan Faith endures. The late Paul Partsch, Keeper of Minerals in the Imperial Museum of Vienna, considered the evidence in favour of the meteoric origin of this object as perfectly reliable. Other stones also greatly reverenced by the Arabians had probably the same origin.

The *Palladium of Troy* was said to have fallen from the sky. It was therefore regarded with great reverence, and was believed to make the town impregnable, Odysseus and Diomedes having to steal it before Troy could be taken. According to Pausanias the images of the Grecian gods in ancient times were rude stones, and many were in existence in 200 A.D. At Orchomenos there was a temple of the Graces in which they were represented by rough stones of an aerolitic nature, which were supposed to have fallen from the sky at the time of Eteokles. Several stones thought to be of heavenly origin were invoked, in Rome, to give victory in military enterprises.

Meteoric stones were given extreme adoration by the Phœnicians, being placed in their temples, instead of

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How Insects Breathe.

1

Section—Human Lung.
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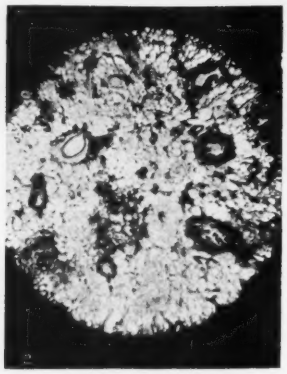
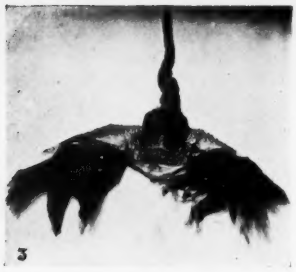


Section—Lung of Cat.
(Copyright, H. W. Venton.)



3

Lungs of Spider.
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5

Silkworm Prepared to Show Breathing Tubes.
(Copyright, H. W. Venton.)

Gills of Young Newt.
(Copyright, H. W. Venton.)

6

Tracheal Tube of Water-Beetle Larva.
(Copyright, H. W. Venton.)

7

Spiracle Larva of Cockchafer.
(Copyright, H. W. Venton.)

8

Grid of Spiracle of Larva of Cockchafer.
(Copyright, H. W. Venton.)

Breathing or Tracheal Tubes of Centipede.
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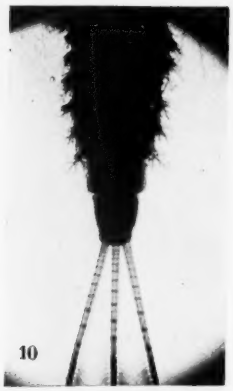

10

Part of Larva Ephemera or May Fly showing Gills on side.
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11

Larva of Gnat showing Breathing Tube at end of tail.
(Copyright, H. W. Venton.)

12

Pupa of Gnat showing Two Breathing Tubes.

13

Tail-Larva of Water-Beetle showing Hairs which enable it to float above water to Breathe.

images. It has been conjectured that the inner court of the Temple of Paphos in Phœnicia contained a *stêlé* or *cippus* of the usual conical shape and possioly of meteoric origin. These *cippi* are called βαιτύλια by the Greeks.

A blackened cone-shaped meteorite which fell at Phrygia, in Asia Minor, was celebrated for many generations. It was worshipped at Pessinus by the Phrygians and Phœnicians as an emblem of Cybele, "the Mother of the gods." Cybele was the great Nature-goddess of Asia. About 204 B.C. it was taken from King Attalus and carried to Rome, because an oracle announced that its possession would secure great prosperity to the State.

Aegos Potami.—The meteorite which fell near Aegos Potami, in Thrace, about 470 B.C. is mentioned by Plutarch in his "Life of Lysander." He tells us that it was of prodigious size, and that the people of Chersonesus held it in great veneration. Diamachus of Platæa relates that for 75 days before the stone fell "there was seen in the heavens a large body of fire, like an inflamed cloud, not fixed to one place, but carried this way and that with a broken and irregular motion; and that by its violent agitation several were impelled in various directions, and darted with the celerity and brightness of so many falling stars." After this remarkable body fell the inhabitants could find nothing but a real stone which seemed to be a fragment of the ball of fire they had seen in the sky.

Plutarch remarks that other people imagined it was nothing but a rock rent by a tempest from the top of a mountain which "after being borne for some time in the air by a whirlwind, settled in the first place where the violence of that abated." Plutarch himself thought that meteorites were really heavenly bodies which "from some relaxation of the rapidity of their motion or by some irregular concussion are loosened, and fall, not so much upon the habitable part of the globe, as into the ocean, which is the reason that their substance is seldom seen."

The above are some of the many meteorites deserving especial mention owing to the important place they held in the estimation of the nations of antiquity to whom they were indeed a marvel and a mystery. Although to a certain extent their origin is now known, yet much of the romance which surrounds them still remains, and to us, as to the people of the past, they are literally "stones from heaven."

A Natural Telephonic Diaphragm.

SOME years ago Professor Tesla showed to a rather dismayed audience at the Royal Institution that it was possible to charge the human body with tremendously high alternating currents of electricity; and most of us have witnessed experiments where, in a smaller way, the body has been used as a sort of charged Leyden jar. It is suggested by Dr. Rieder, of Steglitz, that by charging the body with these rapidly alternating impulses the drum of the ear can be made to respond to their action, and vibrate so as to *hear* the current. The ear would then become a kind of telephone disc and would be aware of changes in the intensity of the current. It is necessary simply to press against the ear the outer metallic coating of a Levden jar whose inner coating is connected with one pole of an induction coil, and to grasp the opposite pole with one hand. The *Revue Scientifique*, in commenting on this experiment, adds that Rieder thinks it not impossible to perfect this arrangement so that it will transmit speech telephonically. It would be interesting to see whether some deaf people might not be sensitive to the device. As Dr. Rieder finds that there is a feeling of oppression in the ear for several hours after such experiments the auditive organs must be acted upon in quite a different way from that of an ordinary telephone. Caution is therefore necessary in tests of this kind.

How Insects Breathe.

By HORACE W. VENTON.

IN the human body the lungs are two in number and occupy the larger part of the thorax, or chest cavity. They are composed of a spongy elastic tissue to allow a very large surface to come into contact with the air, which is supplied to them through the wind-pipe and bronchial tubes. The first illustration shows a very small section of the human lung, magnified about fifty diameters. Its spongy texture is very clearly shown. Each of the small white specks represents a minute cavity which becomes filled with air. An interesting problem for mathematically-inclined readers is to estimate the superficial area which comes into contact with the air. The large holes which are shown in the photograph are, of course, cross sections of the tubes which supply the lung with air. As the blood flows through all the tissue of the lung the exchange of oxygen and carbonic acid is readily effected.

The lungs of most vertebrate animals are of a similar character and differ only in the compactness of the tissue, but in other animals there are various mechanisms of a differing kind. Spiders breathe by means of lungs, but instead of each lung being composed of spongy tissue, it consists of a series of thin plates or laminations. These become filled with air and aerate the blood which flows around them.

Many of the amphibia, such as frogs, toads, and newts in the early or tadpole state of their existence breathe by absorbing the oxygen from the water in which they live. It is a very curious and wonderful fact, however, that they lose their gills by which they breathed during the aquatic part of their existence, and are provided with lungs instead to enable them to breathe the air. An illustration is given of the gills of a newt as typical of the gills of amphibians generally. They form a most beautiful object under the microscope. The actual object from which the photomicrograph was taken was about one-quarter of an inch in length; this will give some idea of the amount of magnification represented by the illustration. Gills act very much in the same way as lungs, only water instead of air is the medium which conveys the oxygen to the bood. It will be noticed that the gills of the newt are finely divided. These divisions in the actual object are almost as fine as hairs, and as the blood flows through each one of them it is in close contact with the water and is able to take up the oxygen dissolved in it.

The method by which insects breathe is entirely different from any of those methods already mentioned. They have no lungs and do not breathe by means of gills. They have, however, a very complex system of tubes running throughout the whole length of the body, by means of which air is conveyed to every part of the system. As they are destined to contain nothing but air, they are strongly supported to guard against collapse from pressure. This support is furnished by means of a fine thread running spirally within the walls of the tube, very much in the same way that a garden hose is protected with wire. There are generally two of these tubes, which run the whole length of the insect's body. The illustration shows a tiny portion of the "tracheal tube" of the larva of a water beetle (*Ascilius sulcatus*), highly magnified. At the right is seen a small length of one of the tubes which connect the main tubes to the spiracles, or little holes along the side of the body, through which the air enters. These

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spiracles are fitted with wonderful devices for filtering the air and preventing dust from entering the respiratory tract. In the case of some insects they are furnished with hairs so placed as to prevent any foreign particles of matter from entering, but at the same time allowing a free passage for the air.

One of the most beautiful of these spiracles as a microscopic object is that of the larva of the cockchafer, an illustration of which is shown. It is an oval aperture closed by a grid of most beautiful construction, which serves to filter the air. Rays of a stronger material than the remainder of the grid radiate from the centre and serve to strengthen it. A small portion of the grid is shown highly magnified, and how great is this magnification will be seen on comparing the micrograph of the portion with that of the whole of the spiracle. Although the centipedes are not classified among the "insects," they also have a system of tracheal tubes through which they breathe. These are disposed in little knots, or ganglia, throughout the body, and an illustration is given of one of these.

There are many flies which, in their larval condition, live in the water, and it will be obvious that these must either breathe by means of gills or that a portion of their body must be out of water. As an illustration of the former mode I have selected a portion of the body of a May fly larva. Arranged along each side of the body is a series of exceedingly thin plates into each of which runs a series of blood vessels. These plates act as gills in the same way as the gills of the young newt, and absorb the oxygen contained in the water. It will be observed that the tail ends in three feather-like projections. By means of these the larva causes currents of water to flow over the gills, and thus their efficiency is increased.

Another insect which lives in the water in its larval condition is the gnat. The larva of the gnat, however, like the fully-developed insect, breathes by means of spiracles and not by means of gills. This being the case, it, of course, is not able to make use of the oxygen contained in the water, but has to breathe the air. This it does by means of a spiracle situated at the very end of its tail. Indeed, the tail is prolonged into a little tube and the larva floats along head downwards in the water with this tube just above the surface to enable it to breathe. After some time it changes into the "pupa" state, and it is then provided with two little tubes which act in the same manner. A provision of a very similar character is found in many other larvæ, the tail of the larva of a water beetle (*Ascilius sulcatus*), for instance, being covered with fine hairs which enable it to float on the surface of the water and thus to breathe through the spiracle at the end.

THE waste water of cellulose factories contain organic matter which is not in itself a source of pollution to streams into which it is thrown, but which may become noxious through fermentation. The best method of preventing fermentation, according to Vogel, consists in diluting the wastes very freely. This may be accomplished by mixing together the ordinary wash water and the alkaline baths in which the raw materials have been boiled for the purpose of freeing the cellulose from other substances. The mixture is then thrown into the stream with violence in order to insure its rapid dissemination through the water. It is not necessary to neutralise wastes laden with sulphurous acid if sufficient dilution is secured, but it must be remembered that fish are killed by one part (by weight) of sulphurous acid in two million parts of water.

Ancient History of the Planet Mercury.

THE Greeks gave this planet two names, Apollo, the god of day, and Mercury, god of thieves. They described it as "sparkling" ($\sigma\tau\iota\lambda\beta\omega\nu$ = stilbon), no doubt in contrast to the steady light of Venus, Jupiter, and Saturn. For a long time they probably thought that Apollo and Mercury were two distinct orbs.

The Romans appear to have been backward in the science of astronomy, and Cicero mentioned that Mercury revolved in an orbit between Venus and Mars, instead of between Venus and the sun. The orator in another passage of his "Dream of Scipio" apparently had come to the correct conclusion that Mercury revolves around the sun, but this idea he probably borrowed from the Egyptians.

The Chinese have observations of the planet dating as far back as 118 A.D. which consist mainly of appulses of Mercury to stars. To the Egyptians he was known as Set and Horus; to the Hindus as Boudha and Rauhineya. The Arabian tribe of the Asedites worshipped Mercury under the name of Otâred, and had a temple in his honour. We know that they were much given to the adoration of the heavenly bodies until the rise of the great Prophet Mohammed.

The Assyrian and Babylonian inscriptions mention Nebo, the god who was supposed to preside over the planet Mercury, very frequently. His special function was to have under his care all learning and knowledge, hence he was called "the god who possesses intelligence," "he who hears from afar," "he who teaches and instructs"; the tablets in the library at Nineveh were said to contain "the wisdom of Nebo." He was the minister of the greater gods and occupied a very secondary position. Like most of the Assyrian deities, he had a female consort—the goddess Urmit or Tasmit. Ishtar or Venus is sometimes mentioned in connection with Nebo, the latter being called her child. The Assyrian king Vul-nirari (B.C. 812 to 745) built temples to Nebo at Nineveh and Calah (now called Nimroud). The temple at Calah was named Bit-sidda after that of Borsippa in Babylonia. It was completed in B.C. 787, when statues of the gods were set up within its sacred walls. Two enormous figures of Nebo, standing in a meditative attitude, were placed one on each side of the main entrance and four smaller statues with inscriptions were put in one of the halls of the building. These smaller ones were dedicated to Nebo by Bel-tarzi-anva, governor of Calah and other towns, in gratitude for the "saving of his lord Vul-nirari and his lady the Queen Sammuramat." Assur-ebil-ili, king of Assyria, restored this temple in about B.C. 607.

Whilst excavating on the site of the temple of Calah (Nimroud) two votive hands belonging to the period of Vul-nirari III. were discovered. And an inscription on a tablet of Tiglath Pileser II. says, "Noble offerings to Bel and Zirat-banit, *Nebo* and Urmitu, Nergal and Laz, the gods, my lords, I poured out." Sargon (B.C. 722 to 705) rebuilt the temple of Nebo at Nineveh.

The "Wonder of Borsippa" or great temple dedicated to the seven planets, *i.e.*, sun, moon, Mercury, Venus, Mars, Jupiter, and Saturn, was thought for a long time to be the remains of the Tower of Babel, until recent excavations brought some clay cylinders to light, on which were inscribed the name of *Nebo;* it is

now known to have been the temple of the planets. It was built of bricks, in seven stages, decreasing in size as they mounted upwards; and each stage was painted a different colour to represent the planet to which it was dedicated. The sphere of Saturn, the most distant of the planets as known to the ancients, was black, the bricks being coated with bitumen. That of Jupiter orange, Mars blood-red; whilst the sun's sphere must have been most gorgeous, being built of unburnt bricks faced with plates of solid gold. Next to this came the pale primrose colour of the Evening Star, and above this Mercury's stage, which was of bricks fused by strong heat to a dim blue colour. Surmounting all was the beautiful silver-coated sphere of the moon, containing the sacred shrine into which none but the priest might enter.

The country being flat the Wonder of Borsippa must have been visible for miles, and from its terraces the Chaldean astronomers obtained clear views of the star-spangled sky. This glorious structure was built by Nebuchadnezzar, king of Babylon (B.C. 605 to 562). But, as he himself states, there had been a still more ancient temple on the same site. "I have completed the magnificence of the tower with silver, gold, precious stones, enamelled bricks, fir, and pine. This most ancient monument of Borsippa is the house of *the seven lights* of the earth. A former king built it—they reckon 42 ages ago, but he did not complete its head. . . I made it as it had been in the ancient days. . . O, *Nebo*, be propitious to my works; . . grant me a life to the remotest times; . . triumphs in many lands; . . may Nebuchadnezzar, the king-repairer, live before thee." His wish has been granted in so far as the *knowledge* of his might has, indeed, come down to these days; but the Wonder of Borsippa is but a heap of ruins from which many scientific treasures have been unearthed.

On the pupil of the eye of a statue of Nebo is a dedication composed by Nebuchadnezzar: "To the god *Nebo*, his lord, Nebuchadnezzar, king of Babylon, son of Nabopolassar, king of Babylon, for his preservation he made."

The treasuries of the temple of Borsippa were broken into by Suzub, king of Babylon, in B.C. 692, and the gold and silver was sent to Umman-minan, king of Elam, as a present, to get his help against Sennacherib, king of Assyria.

An inscription has been found in the ruins of the once mighty city of Babylon which says: "This is the great palace of Nebuchadnezzar, king of Babylon, who walked in the worship of the gods *Nebo* and Merodach, his lords." In another tablet Tiglath Pileser, when describing one of his numerous hunting expeditions, tells us: "By the help of my guardian, god *Nebo*, I laid low eight hundred lions. All the beasts of the field and the birds of heaven I made victims of my shafts."

Mercury is alluded to in a report sent by the chief astronomer of Nineveh to Assurbanipal (B.C. 648-626).

An ancient observation of Mercury made in the year B.C. 265 has been handed down to us in Ptolemy's *Almagest*. The planet was then noticed to be "distant from the right line, joining the stars called β and δ Scorpii, one diameter of the moon, and from the star β two diameters towards the north and following it in Right Ascension." Naturally, Mercury did not attract as much notice as the brilliant Venus or Jupiter, for he is rarely so conspicuous as the latter orb and then only for a very brief period; the ancient records of him are, therefore, scanty.

Müllerian or Convergent Mimicry.

By PERCY COLLINS.

SOME years ago the present writer contributed to the pages of "KNOWLEDGE & SCIENTIFIC NEWS" several short papers dealing with "protective resemblance" and "mimicry" among insects. In so doing it was his aim to supply a brief summary of a subject which, year by year, seems to grow in interest and importance. The articles in question were intended chiefly for the perusal of the young student as yet unfamiliar with many of the terms and examples which are constantly employed by entomologists of maturer years. It may not be out of place to present a brief recapitulation before attempting to explain the theory of "convergent mimicry." Firstly, we dwelt upon the protection resemblance of insects—the simple likeness of the organism to its surroundings, whereby it gains immunity from the assaults of its enemies. Incidentally, we realised how the likeness of an insect to its surroundings may, in certain cases, assist it in capturing the smaller insects upon which it preys; also that more than one species of the family *Mantidæ* possesses a more or less elaborate resemblance to a flower—a resemblance which actually attracts butterflies, bees, and the like to their destruction. Under the title "Terrifying Masks and Warning Liveries" we brought into prominence two facts, viz., that certain insects are protected from molestation by their grotesque or terrifying appearance, and that other insects (they constitute a very numerous assemblage, by the way) are endowed with a definite noxious characteristic, such as a sting or an offensive odour, and that this characteristic is advertised by a striking or unusual combination of colours. The latter fact made it possible for us fully to comprehend the significance of the term "mimicry." We saw that many ill-protected insects, because of their superficial likeness to other insects which are well protected, share in their immunity from attack. The well-protected species, by the way, is often referred to as the "model," while the ill-protected species is termed the "mimic."

There remains, however, a phase of mimetic relationship among insects with which we have not dealt, viz., the mutual likeness which not infrequently exists between two species both belonging to well-protected groups. Many such instances were observed by Bates, although he did not attempt to explain them. It remained for Dr. Fritz Müller, a German naturalist resident in Brazil, to advance the theory which has seemed to dispel much of the mystery which at first obscured this phase of entomological study.

The reader should be reminded that the theory of warning coloration is founded in great measure upon the assumption that young birds, lizards, and other insectivorous creatures do not inherit the power to discriminate between what may, and what may not, be eaten with impunity. They are at first inexperienced. They must gain their knowledge by testing and tasting. But the warning colours of insects, coupled as they usually are with inedible qualities, are early impressed upon the senses of young birds and reptiles; and in this way the necessity for experimental tasting is reduced to a minimum in the case of a given species. At the same time the reader will perceive that experimental tasting, with the inevitable sacrifice of insect life, cannot be entirely done away with. It must come into play as soon as each new generation of young animals begins to fend for itself.

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We see, therefore, that well-protected, warningly-coloured insects are not absolutely, although comparatively, exempt from attack. A certain number must perish each year in order that inexperienced insectivorous creatures may learn their lesson. Upon this ground Dr. Fritz Müller argued that a definite advantage to noxious insects might be supposed to accrue from a reduction in the number of warning-colour liveries. It seems clear that the larger the number of individuals from which the victims of experimental tasting are chosen, the smaller will be the relative loss to each species. Let us suppose, for example, that we have two species of butterflies belonging respectively to two distinct families, both being well protected. If each of these two butterflies has a warning livery, sufficiently striking, but entirely different from that possessed by the other, an equal number of each species may, on an average, be expected to fall victims to inexperienced birds, lizards, etc. But if we imagine a case of convergent mimicry, in which the warning liveries of the two species in question have become so alike as to deceive the eye of man himself, we shall be ready to admit that insectivorous creatures will gain experience of warning colouration and its meaning more quickly, and with less experimental tasting, than would be the case if the two species were coloured on an entirely different plan. In fact, there seems to be justification for assuming that the number of victims in the case of each species would be reduced by half.

An actual case from Nature may be cited. In the accompanying photograph are two distinct species of butterfly from Bogota, Columbia. The upper one, *Melinea messatis*, belongs to the *Ithomiinæ;* the lower, *Heliconius ismenius*, to the *Heliconinæ*. Now these two sub-families are perfectly distinct. They are separated by certain fundamental structural characters which are at once recognisable to the eye of the experienced entomologist, just as among plants the botanist separates the buttercups from the roses. Moreover, both the *Ithomiinæ* and the *Heliconinæ* are groups of well-protected butterflies, so that the present may be regarded as a typical instance of Müllerian or convergent mimicry. A more perfect mutual likeness could scarcely be imagined. The tints of the two butterflies are identical in tone, while the design—the arrangement of the colours upon the wing-surface—is so nearly identical that a highly critical examination is necessary to detect the few slight differences which exist. If, then, we accord our acceptance to the theory of warning colouration, we seem bound to admit that the relative loss to each of these species must be minimised when the two possess what is, in fact, a common type of colour and pattern.

Another possible instance of convergent mimicry is seen in *Colœnais dido* and *Victorina steneles*. Here we have two butterflies belonging to the same sub-family (*Nymphalinæ*), but to different and widely separated genera, whose colour and design might easily lead to the one being mistaken for the other. Both species are distasteful, both inhabit the tropics of South America, and it is interesting to note that each is very dissimilar in colour and design to the other species of its genus. *V. steneles* is more like *C. dido* than it is like the other species of *Victorina*, and *vice versâ*.

One other instance of the same kind may be mentioned. In this case we have another species of *Colœnais* (*C. telesiphe*) which closely resembles *Heliconius telesiphe*. The two species are from Bolivia. Save for the fact that the former has the exterior margin of the forewings rather angular, the two insects might easily be misaken for individuals of the same species. In colour and design they are almost identical. Yet the respective sub-families to which they belong differ widely one from the other.

The strongest support, however, to Müller's theory of convergent mimicry is not supplied by some isolated instances, striking though many of them undoubtedly are. It consists rather in the tendency which exists among evil-tasting insects as a whole, both in the eastern and western tropics, to converge towards a common warning-colour type. This fact is of comparatively recent observation.

A good instance is found in the case of the African genus *Amauris*. The wings of nearly all the species are dark as to ground tint, with several large white patches. To all intents and purposes the colour scheme is identical—differing somewhat in detail, but producing exactly the same effect upon the eye of the observer. The accompanying photograph of six typical species of *Amauris* from different localities of South and West Africa bear out this point. The reader will at once perceive the remarkable common likeness which exists among all these butterflies. One may suppose that the colour scheme of each insect is converging, so to speak, towards a common type, under the guidance of natural selection ; and the process has advanced so far as to be at once appreciable to the most casual observer. According to the Müllerian theory, each species of the family is benefited in proportion as its individuals resemble more or less closely the ideal warning-colour type towards which the whole group tends.

Another family of butterflies, also African, which strikingly illustrates the point under consideration is the *Acræinæ*. Its members are for the most part tawny and reddish butterflies marked and spotted with black. Upon a critical examination the differences of tint and marking which exist between the various members of the group are perfectly apparent. Yet, if one regard the group as a whole, one is at once impressed by the fact that a common type of colour and design holds good throughout scores of species. The *Acræinæ* are well known to be distasteful butterflies. They are mimicked by numerous species belonging to poorly protected groups. Thus we may conclude that here also is a case of Müllerian mimicry.

Instances in support of the theory of convergent mimicry might be multiplied indefinitely. In South America especially, where butterfly life is so extraordinarily abundant, hundreds of species—perfectly distinct in every other particular—are intimately connected by a common type of colour and design. The shape of the wings, too, tends towards a striking similarity.

So far we have drawn our instances of Müllerian mimicry from butterflies alone. But the theory finds ample support among orders of insects other than *Lepidoptera*. Among South African insects, for example, there is observable a general tendency among well-protected groups to converge towards a special shade of reddish-orange banded with black. This type of colour occurs among *Coleoptera*, *Homoptera*, *Hymenoptera*, and *Lepidoptera*, the similarity being often exceedingly striking. Thus, at the British Museum (Natural History) at South Kensington there is exhibited a series of specimens collected by Mr. Guy K. A. Marshall at Salisbury, Mashonaland, which include representatives of no less than eight distinct families of *Coleoptera*, two families of *Homoptera*, two of *Hymenoptera*, and a single representative of *Lepidoptera*. Not only do all these species bear a striking resemblance to one another in outline when they are at rest with folded wings, but the disposal of the yellow and black patches with which their wings or

wing-cases are marked is almost identical, as are also the tones of the colours.

The reader will perceive that, in the case of ordinary mimicry, the ill-protected insect must be less numerous in individuals than in its model. Bates noted that none of the Pierid mimics were so abundant as their distasteful models. If they were, their protection would be less; while should the mimic exceed the model in numbers, the former would obviously become more subject to attack than the latter. In Müllerian mimicry, however, the variation in abundance of two or more converging and protected species is likely to be less disastrous; though when two equally well-protected species are involved, the rarer has the advantage. Thus, Dr. Fritz Müller supposes that the young insectivorous creatures of a given region have to destroy 1,200 butterflies of a distasteful species ere they become sufficiently educated to recognise the said species as inedible. He further supposes that there exist in this region 2,000 individuals of a species A and 10,000 of a species B. It follows that if these species differ in appearance each will lose 1,200 individuals, but if they resemble one another this loss will be divided among them in proportion to their number, viz., A will lose 200 and B 1,000. So that A saves 50 per cent., of the total number of the individual members of the species, while B saves only 2 per cent. Thus, while the relative numbers of the two species are as one to five, the relative advantage from their resemblance is as twenty-five to one.

The Graphic Representation of Harmonograph Curves.

By CHARLES E. BENHAM.

IN the year 1835 the late Mr. Henry Perigal, F.R.A.S., discovered what he called "kinematic" curves, which he first produced by geometric formulæ and five years later mechanically by means of a geometric chuck. These curves were identical with the well-known Lissajous figures and those of the ordinary rectangular harmonograph, but Perigal's little book illustrating his interesting figures long preceded any attempt to produce similar curves with the compound vibration pendulum. The pamphlet does not give any practical instructions for tracing the curves geometrically, but the diagrams are sufficiently self-explanatory for anyone who is a student of the subject. As it is of some interest to workers with the harmonograph to be able to trace by hand the curve resulting from compounding two harmonic movements of any given ratio of period and in any given phase, a few words of explanation and direction in popular terms may be acceptable.

It is well known that the period of a gimbal-mounted pendulum is the same, whether it is swinging in a circular orbit or backwards and forwards in a straight line. But while in the circular orbit it moves with uniform velocity throughout the circle; its velocity varies at different parts of the orbit when it has a rectilinear path. Fig. 1 illustrates graphically the two cases. The circular orbit, A B C D, is represented as divided into six equal parts, each of which is traversed in the sixth part of the whole time occupied in a complete revolution. The straight-line movement is represented by the line A C, which, as a whole, is traversed in the same time as the circle. The dotted lines from the six points of the circle necessarily cut the line A C into six parts, each of which is traversed in the same period as the arc corresponding with them, *i.e.*, into six parts, unequal in length, but each of which is traversed in an equal period of time, viz., one-sixth of the time occupied by the complete oscillation to and fro. The diagram looks as if the line were divided into only three parts, but it must be remembered that the whole oscillation includes the returning as well as the going, so that the three are really six divisions, as shown by the six arrows.

The line, therefore, it must be clearly understood, is divided into six fractions of the orbit, unequal as to space, but equal as to time. Dividing a circle into any number of equal parts, say 12 or 24, its diameter may be similarly divided into the same number of parts, very unequal in length, but over each one of which the pendulum takes the same time to travel, namely, one-twelfth or one twenty-fourth of the period of the whole oscillation to and fro.

This principle being clear, a sheet of paper may be easily prepared divided into rectangles which, though differing in

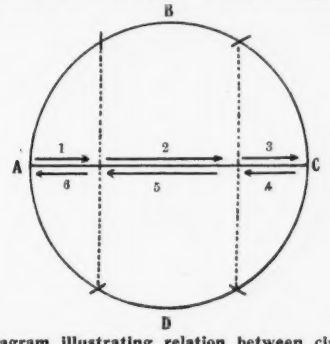

Fig. 1.—Diagram illustrating relation between circular and rectilinear oscillations.

cubic space, may be looked upon as squares in point of time. To do this divide the circle (see Fig. 2) into 24 equal parts, and rule lines joining the 24 division points both horizontally and vertically. This, as regards time, is a "squared paper" suitable for graphically representing the curves of compounded movement produced by two pendulums travelling in straight-line orbits at right angles to each other. Each side of any rectangle is traversed in exactly the same time as any side of any other, no matter how they differ in area. It is only requisite to assume that the two pendulums are swinging in one and the same period.

To figure the curve of compounded movement on such a "time-square" paper is obviously simple. Suppose the two pendulums to be of the same period and in the same phase. That is to say, let them oscillate at the same rate and start together from the extreme limits of their respec-

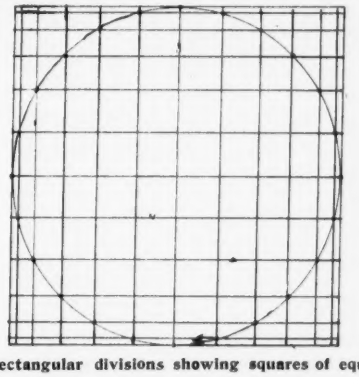

Fig. 2.—Rectangular divisions showing squares of equal time.

tive orbits. Then the vertically-moving pendulum will just have crossed the first square in the downward direction by the time the other pendulum will have crossed it horizontally from left to right. Therefore the resultant curve will touch the bottom right-hand corner of the first square. From this point a similar concurrence can be traced at the bottom right-hand corner of the next square, and so on, the whole resultant being a diagonal line across the whole paper, and made up of the diagonals of the consecutive squares.

But if the two pendulums are assumed to be not in the same phase, but starting one from the limit of its path while the other starts from midway along the line, it will be found that, marking by a dot the successive points of concurrence

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as each square is crossed vertically and horizontally, the 24 dots will be ranged in circular form. This diagonal line and circle are respectively the two forms of the unison figure in similar and in halfway-differing phase. Any intermediate phase is an ellipse, narrowing as it aproximates the phase of the diagonal line.

To make the method of tracing perfectly plain, let the lines of the squared paper be numbered vertically and horizontally along the side and top of the paper, and place a dot at the intersection of the lines from the two 1's, the two 2's, and so on. Joining up the dots, a diagonal line will be produced as the resultant if each series of numbers commenced at the extreme end of the square and a circle if one series commenced at the extreme end and the other in the middle of the line.

There is no need to rule up a separate piece of paper for each figure. Let the squared paper, drawn in a black ink, be placed under a piece of tracing paper on which the numbers that are to act as guides and the points of intersection can be noted. Then the diagonal, the circle, or the ellipse can each be traced on three separate pieces of thin paper with the guidance of the same squared paper underneath.

To trace harmonies other than unison it is only necessary to number the lines vertically and horizontally in accordance with the ratio, and join up the intersecting points as before. Thus, for a 1 : 2 harmony, bearing in mind that one movement is supposed to be twice as fast as the other, the vertical

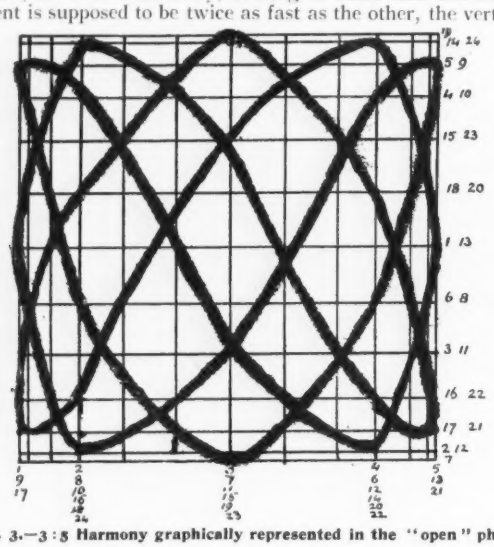

Fig. 3.—3 : 5 Harmony graphically represented in the "open" phase.

series may be numbered as before, but the horizontal series must include two squares each time, every alternate line being missed, because double the distance is travelled in an equal interval of time. Numbering the vertical and horizontal lines in this proportion the 1 : 2 harmonograph figure may be rendered in its various phases, from the parabola of the "closed" phase to the figure-of-eight form of the "open" phase.

For a 3 : 4 harmony number the vertical lines, only counting every third line, and the horizontal series at every fourth line, numbering backwards and forwards from 1 to 24 in each case. Place a dot at the intersecting point of each pair of 1's, each pair of 2's, and so on, and the curve is given, the configuration as to phase being determined by the relative starting points of the vertical and horizontal series of numbers.

The guide numbers, the dots marking the intersection points, and the curve itself are all indicated on the tracing paper by the aid of the squared paper underneath. Fig. 3, which shows the application of the method to produce the curve of a 3 : 5 harmony in the open phase, will sufficiently illustrate the mode of procedure to render it unnecessary to give further examples, though there is no limit to the variety of ratios and phases that can be represented.

(To be continued.)

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

BRIGHTNESS OF SOLAR CORONA.—During the total solar eclipses of August 30, 1905, and January 3, 1908, observations were made by the Lick Observatory parties to determine the total brightness of the corona by photographic methods, and Professor C. D. Perrine presents a short summary of the results. In 1905 it was attempted to compare the brightness of the corona directly with lunar intensity-squares impressed on the same negatives, the light from the corona and surrounding sky for a radius of about 2° from the sun's centre being allowed to shine on the central portion of a sensitive plate without the intervention of any lenses, thus obtaining an integrating effect. Although the low declination of the previous full moon and clouds during totality rendered the results uncertain; two facts were revealed (1) that the greater part of the coronal light came from a very narrow ring about the moon's disc; (2) a very large prominence on the east limb of the sun showed a distinct effect, estimated to be about one-quarter or one-third the amount of light received from the corona proper.

At the eclipse of January 3, 1908, the attempt was repeated in a different manner. Instead of comparing the corona intensities directly with the moon, a Hefner standard lamp was used as intermediate standard, and as the lunar intensities could by this method be obtained under better conditions, it is believed that better results are secured in this way. Two plates were exposed at Flint Island, one at mid-totality for 4 secs., the other near the end of totality for 10 secs. ± 2 secs. The sky near was free from clouds during both exposures. From the measurement of these plates the following results were obtained.

Total actinic brightness of Corona + sky area	= 9.0 Hefner lamp units.
" " sky area	3.0
Total actinic brightness of Corona	= 6.0

On March 17, 1908, a determination of the brightness of the full moon was made under similar conditions to the eclipse observations, the resulting value being 54.1 lamp units.

Taking the average width of the coronal ring as 1′ of arc, the area of the radiating annulus is 110 square minutes, giving an average intrinsic intensity of 2.02. The final value for the comparison then is that the total illumination from the corona is about 0.111, or, say, one-tenth, that of full moonlight.

It seems possible that by this method it may be possible to detect the differences of brightness of the corona at different eclipses.—(*Lick Observatory Bulletin*, No. 153.)

SPECTRA OF SPIRAL NEBULÆ AND GLOBULAR STAR CLUSTERS.—In an investigation recently undertaken by Mr. E. A. Fath at the Lick Observatory, it was sought to obtain definite evidence to test the correctness of the prevalent idea that the spectra of spiral nebulæ are continuous. Evidence casting some doubt on this theory has previously been obtained by Scheiner and Huggins, who found dark absorption lines in the spectrum of the Andromeda nebula. The Lick apparatus has been specially designed for photographing the spectra of faint objects, and consists of a small spectrograph attached to the 36-inch Crossley reflector. The prism is of light flint with angle about 30°, collimater of 54 mm. aperture, aud 315 mm. focal length. The camera lens in a combination of two plano-convex

lenses having an aperture of 51 mm., and an equivalent focal length of 155 mm. For reducing the spectra a hydrogen comparison was used. The scale of the spectra is such that from 3727 to 5007 is about 3.3 mm. Exposures had in several cases to be continued from night to night, amounting in one case to a total of 18h. 11m. for the Andromeda nebula, whose spectrum is apparently of the solar type. No bright lines, as reported by Huggins, can be found on either of the plates examined. Fourteen absorption lines have been measured. The general conclusion appears to be that no spiral nebula among the number investigated has a truly continuous spectrum. The globular clusters appear to show the dark lines of hydrogen, calcium, and possibly iron.

COMET DANIEL (1909a).—On June 16, an announcement was made from Kiel of the discovery of a faint comet by Mr. Daniel, of Princeton, U.S.A. Its position on June 15 was R.A. = 1h. 39m. 54s.; Decl. = + 28° 55′, being located near *a* Trianguli. A later telegram stated that the comet had been observed at the Nice Observatory by Mr. Javelle, its position on June 16, 13h. 13.3m., being R.A. = 1h. 41m. 54s.; Decl. = + 29° 58′ 18″. From this it will be seen that the motion of the comet is rapid and northerly.

Circular 109 from the Kiel Centralstelle contains the following elements and ephemeris :—

τ = 1909, June 5.3515 Berlin Mean Time.
ω = 5° 3′.54
A = 305° 21.32 } 1909.0
i = 155 3.62
log q = 9·92524

	R.A.	Decl.
Position on July 4	2 42 40	+51° 9′
,, ,, 8	2 59 22	+54 22.9

BOTANY.

By G. MASSEE.

THE TAXINE IN IRISH YEW.—Although the poisonous nature of the Yew has been well known for centuries, it is only recently that the supposed poisonous alkaloid substance, taxine, has been extracted and carefully examined by T. E. Thorpe, C.B., F.R.S., and George Stubbs. Mr. R. J. Moss gives an account of his investigations on the leaves and fruit of the Irish Yew, *Taxus baccata*, var. *fastigiata*, in the *Scient. Proc. Roy. Dublin Soc.* The amount of the poisonous principle varies considerably in the leaves of different trees. In one instance where the leaves were obtained from a female Irish Yew, it amounted to 0.596 per cent. of the original leaves. A second example of the same kind of tree yielded 0.323 per cent. The leaves of a male specimen of the common Yew yielded 0.082 per cent. The marked variation in the quantity of alkaloidal substance present in different trees explain, to some extent, the widely different opinions expressed as to the toxic properties of the Yew.

Taxine appears to be more constant in quantity in the seed than in the leaves, the percentage being 0.079 and 0.082 respectively in two lots examined. The arillus or brightly coloured fleshy part surrounding the seeds is quite free from taxine.

The investigations suggest that the Irish Yew contains much more taxine than the common Yew, and many of the cases of poisoning by the seeds of Yew are probably attributable to the Irish Yew, as the trees are often referred to as growing in cemeteries, where the Irish Yew is very frequently planted.

WHY THE SPHAGNACEÆ DISLIKE LIME.—H. Paul discusses in *Milt. Bayr. Moorkult.* the reason why the species of *Sphagnum* dislike lime. Calcium carbonate, and not calcium sulphate, is the substance which determines their presence or absence in a given locality. The acidity of those mosses present on elevated moors is much greater than those growing on lowland plains. The acid enables the moss to dissolve nutritive substances, and is most abundant where but little wind-borne matter reaches the plants, hence such mosses are very sensitive to the neutralisation of their acid by lime. The sensitiveness to neutralisation and the amount of acidity diminish in lower localities where more mineral matter is available.

RELATION OF SEX IN SPHÆROCARPUS.—The spores in *Sphærocarpus* are produced in tetrads, and C. Donin has conducted a series of experiments for the purpose of determining whether the four plants resulting from the germination of the four spores are of different sex. The result showed that, as a very general rule, the four spores of a tetrad produce two male and two female plants.—*Revue Bryologique.*

PARTHENOGENESIS IN PINUS PINASTER.—W. T. Saxton, South African College, Capetown, during an investigation on the development of the embryo of the cluster pine, *Pinus pinaster*, Soland, obtained evidence showing clearly that parthenogenesis sometimes occurs. As far as observed, the abortion of the ovule frequently occurs before the formation of a proembryo, but never after. As the proembryo is perfectly formed in the observed cases of parthenogenesis it would appear that in such cases the embryo must develop as well as the normal ones. It is impossible to state whether the development is only intraseminal, or whether seeds containing such embryos are able to germinate and produce normal plants.

BOG TOXINS.—A. Dachnowski gives an account in *Bot. Gaz.* of certain investigations on certain extensive swamp areas in the United States. They are noted for their dense and luxuriant surface vegetation; however, from an agricultural standpoint, these swamp lands seldom give satisfaction, even after drainage and addition of fertilisers. This is, in part at least, due to the presence in the water of injurious toxic substances. This toxicity appears to be partly due to a certain unstable body of the nature of organic compounds excreted by roots in the absence of oxygen, being probably a product of imperfect oxidation and decomposition of proteins and other related substances, and it is possible that in respiration bog plants differ from other plants. The author considers that there are present in bog water and bog soils injurious substances, which are, at least in part, the cause of xerophily in plants, and of decreased fertility in bog soils. Fertility is restored through aeration, that is, after time enough has elapsed for the oxidation of the injurious bodies.

AMERICAN SEAWEEDS.—The large red and brown seaweeds are frequently attacked by other algæ microscopic in size and only to be studied with the microscope. A number of these minute endophytes have been described for Europe. N. L. Gardner, in a recent paper, deals with some new Californian species, all of which belong to the group of algæ known as Chlorophyceæ (*i.e.*, those which possess chlorophyll only as a colouring matter). The author is mainly concerned with the systematic position of the algæ, and does not touch upon the more interesting biological aspect of these minute and curious plants.

The coral-like algæ encrusted with a coating of carbonate of lime are among the most perplexing to classify on account of the difficulty in examining their microscopic structure. The Norwegian botanist, Foslie, has long made this group his special study, and is the acknowledged authority on the subject. Recently M. B. Nichols has undertaken a critical investigation of certain Californian species. Two papers have appeared by him describing in detail the species dealt with. The author differs from Foslie in certain respects, but reserves his final opinion for a future communication.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

THE VINEGAR ENZYME.—In the manufacture of vinegar an infusion of malt, or other solution containing sugar, is fermented with yeast, and the fermented liquid subjected to

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a further fermentation with acetic bacteria. For this purpose it is continuously pumped over and over in vats containing shavings, basketwork, or other porous material, while a current of air is meanwhile passed through it. Under these conditions at a suitably high temperature the bacteria slowly oxidise the whole of the alcohol present into acetic acid, and the *gyle*, as it is technically called, becomes vinegar. Usually there is a very large loss, and the amount of acetic acid theoretically attainable is never reached. This loss may be minimised, however, by so regulating the supply of atmospheric oxygen that the bacteria obtain sufficient for the chemical transformation, without the admission of too great an excess, which will result in the further oxidation of the acetic acid already formed.

When Dr. E. Buchner made his classical discovery that the fermentation of sugar into alcohol by yeast was brought about by an enzyme within the yeast cell, and that that enzyme could be separated from the ruptured cell by means of enormous pressure, the thought at once suggested itself that the acetic fermentation was probably caused by a similar enzyme within the bacteria. Numerous experiments were, therefore, made to separate this enzyme by crushing the micro-organisms with fine quartz sand and then expressing the contents of the cells. So far, however, it has not been found possible to isolate any substance that would bring about acetic fermentation apart from the living cells of the bacteria. At the same time, analogy with cases in which this has been done leads to the conclusion that the oxidation of the alcohol is effected by means of an intracellular enzyme which, however, must be much more closely attached to the living cell than the zymase of yeast.

Acetic fermentation, like other enzymic actions, is readily inhibited by the presence of numerous substances, such as salts of certain metals, hydrocyanic acid, etc. Like them also it has an *optimum* temperature, and the conversion of alcohol into acetic acid proceeds best at temperatures between 90° and 110° F. The temperatures at which the bacteria work in this country affords a striking instance of the acclimatisation of an enzyme to its environment. On the Continent the vinegar bacteria have become acclimatised to produce their best results at a temperature of about 90° to 95° F., and the bacteria die when the temperature is raised a little above 100° F. These statements will be found in various chemical text-books, many of which have copied them from one another. The present writer has had the opportunity of testing the truth of this upon a manufacturing scale, and has found that in this country, at all events, the effect of gradually raising the temperature of acetification has been to raise the *optimum* temperature for the action of the enzyme. Hence we have here the curious phenomenon of bacteria (or their enzyme) doing their best work at 108° to 110° F., *i.e.*, at a temperature above the thermal death point of the micro-organisms as given in the text-books.

TREATMENT OF COAL DUST IN MINES.—A method of preventing the distribution of coal dust in mines is described by Mr. H. Hall in the Transactions of the Mining Institute of Scotland. It consists in watering the dust with a concentrated solution of calcium chloride, and introducing the same salt, in the form of a dry powder, into seams where watering is not possible. This treatment is claimed to "lay" the dust effectually, and need only be applied once every three months. Comparative experiments to determine the corrosiveness of such a concentrated solution of calcium chloride upon iron showed that that metal was oxidised much more rapidly by alternate exposure to air and ordinary tap-water than to air and calcium chloride solution. The metal lost in weight about three times as much when immersed in water as when placed in the solution of the salt.

CHLORINISED WOOL.—The wool used in the manufacture of unshrinkable underwear is usually chlorinised by treatment with an alkaline hypochlorite solution to which hydrochloric acid is afterwards added. This liberates the chlorine, which acts upon the scales of the wool, smoothing them down, and causing the fibres to change their properties. After this treatment the wool is thoroughly washed, and then treated with dilute nascent sulphurous acid to restore its colour, and washed with soap and a little sodium carbonate. Owing to the action of the chlorine the tendency of the fibre to shrink on contact with water is enormously reduced, but the wool is considerably weakened in the process, and garments made from it do not last so long as untreated wool. Chlorinised wool may be distinguished from ordinary wool by its greater affinity for dyestuffs, and by the different manner in which it absorbs a drop of water placed upon it. It has also been pointed out by Mr. H. Pearson that on rubbing together ordinary wool and chlorinised wool an electric charge is produced of sufficient strength to give pronounced indications in an electroscope.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

A PRE-NEANDERTHAL RACE.—In the *American Journal of Science* are some useful particulars of the discovery of *Homo Heidelbergensis* in a sandpit near the village of Mauer, Heidelberg, by Dr. Schoetensack. The lower human jaw, which constitutes the find, was found in Lower Quaternary Sands, 24.1 metres from the surface. The same horizon has yielded other fossil mammalian remains, including *Felis spelæa*, *Ursus arvernensis*, *Cervus latifrons*, Bison, Equus, *Rhinoceros etruscus* and *Elephas antiquus*. The jaw was notable for the absence of a chin. G. G. McCurdy, who describes the specimen, remarks that "the symphysial region is somewhat gorilloid, while the ascending ramus suggests rather the Gibbon. The teeth, however, are distinctly human and are relatively small in comparison to the size of the jaw. The dentition of *Homo Heidelbergensis* represents a youthful stage in the dentition of the modern European. That is to say, in the ontogeny of the latter, a stage representing adult dental characters when the race was young is now reached at the age of from nine to fourteen." The jaw bears a general resemblance to the *Pithecanthropus erectus* of Dubois, and represents an earlier race than *Homo primigenius*, or the Neanderthal race. Its pre-anthropoid characters are noteworthy.

THE SEAFORD CHALK.—Mr. J. V. Elsden's paper on the Geology of the Neighbourhood of Seaford, Sussex, read before the Geological Society, illustrates the application of zonal methods to field-geology in a Chalk area. It deals with a portion of the South Downs lying between Eastbourne and Newhaven. In tracing the boundary-lines of the zones of the chalk fossil evidence is alone relied upon, lithological characters being found untrustworthy. On the east of the Cuckmere River the beds examined are found to be nearly horizontal. On the west side they are bent into a sharp uniclinal fold, striking east and west. Seaford Head represents a remnant of this fold, the westerly extension of which is destroyed by marine erosion. The low ground between Seaford and Chyngton occupies the trough of the fold, from which dip slopes rise gently to the north and sharply to the south. There is thus formed a true synclinal depression striking westwards, with a low pitch, into the English Channel. The complete disappearance of the fold on crossing the river Cuckmere cannot be satisfactorily explained by the normal process of dying-out, the distance being too short for so rapid a recovery. It is suggested, therefore, that a transverse fault may exist beneath the alluvium of the Cuckmere, thus, perhaps, accounting for the narrow gorge at Cuckmere Haven. The top of the zone of *Marsupites testudinarius*, which lies in an approximately horizontal position at about the level of the 300-foot contour on one side of the river, sinks below sea-level in the trough of the fold on the other side. The fault, if it exists, seems to die away rapidly northwards, since no trace of it has been detected higher up the valley towards Alfriston. This feature would be expected from the nature of the movement. It is suggested that the Seaford fold represents the eastern termination of the structural area known as the Hampshire basin, being, in fact, a continuation, *en échelon*, of the Purbeck-Isle-of-Wight system. Certain existing physiographical features are ascribed to the influence of this

flexure, which facilitated the retention of the Eocene cover in the synclinal hollow thus formed. A result of mapping the outcrops has been to prove that the numerous dry valleys in this area are not of the nature of "sinks" or "dolinas," but are true valleys of surface-erosion.

THE PITTING OF FLINT-SURFACES.—On May 26 a paper was read by C. Carus-Wilson, F.G.S., on "The Pitting of Flint-Surfaces." Regular pittings of uniform size, he states, are occasionally seen on flints which have been exposed to the weather. They have been referred to by various authors, but no satisfactory explanation of their origin has been given. The author procured some interesting examples occurring in a recent deposit near Folkestone. This deposit is formed of materials which appear to have been washed down from the adjacent chalk-hills. The flints appear to have been derived from the sandpipes in the Chalk: their surfaces are much decomposed. The removal of the colloid silica has rendered them very porous, and they absorb a good deal of water. It is believed that the pittings are due to mechanical action. Observations and experiments carried out indicate that such markings cannot have been produced by blows, nor by any process of desiccation, and that the freezing of the absorbed water seems to be the only satisfactory explanation to account for the various details of the phenomenon.

BRAUN'S MINERAL KINGDOM.—I should like to call attention to the publication, in 25 two-shilling parts, of Dr. Reinhard Braun's "Mineral Kingdom," translated with additions by Mr. L. J. Spencer, of the British Museum (Williams and Norgate). Each part contains three or four quarto-size plates of minerals, printed in colours, most realistically representing various varieties of the minerals described in the text. I know of nothing like it having been published before. Next to having a thoroughly good collection of minerals, such as few possess, this is decidedly the best thing that a student should have. The language used is such that appeals to the tyro, as well as to the advanced student.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

VARIABILITY OF TEMPERATURE IN ARCTIC REGIONS.—Mr. R. C. Mossman, F.R.S.E., who was the meteorologist in the Scottish National Antarctic Expedition, and is now in the Argentine Meteorological Office at Buenos Aires, communicated a paper on the "Interdiurnal Variability of Temperature in Antarctic and sub-Antarctic Regions" to the Royal Meteorological Society on June 16. The variability of temperature is least in oceanic, and greatest in continental localities. Where there is much moisture the day to day changes are small, but in continental regions, where there is little water-vapour, great temperature changes take place. Mr. Mossman pointed out that an important factor in this connection is the position which the station occupies with reference to the track of cyclones, because the greater the frequency of wind-variation the larger will be the variability. This cyclonic effect is at a winter maximum at such places as the South Orkneys, which for some six months of the year are on the edge of a continent, owing to the freezing up of the Antarctic Ocean, while, at the same time, strictly oceanic conditions prevail at no great distance to the north of the station. At the South Orkneys there was a very great difference in the mean temperature of the winds. For the seven months, April to October, 1903, the South wind had a mean temperature of only 5°.2, while the North-west was as high as 26°.9, a difference of 21°.7. At Cape Pembroke, Falkland Islands, there was only a difference of 7°.0 between the warmest and coldest wind during the same period. It is, therefore, easy to understand why the variability of temperature should be so much greater at the southern station, as the South Orkneys further appear to lie in or near to the central track of the rapidly moving cyclonic systems, which, after passing south of Cape Horn, frequently strike south-east into the Weddell Sea, a little to the west of the South Orkney group. The Falkland Islands, on the other hand, lie well to the north of the normal cyclonic track, and here the changes in wind direction were not nearly so sharp as at the southern station, where the temperature contrast between a sea and what is essentially a land-wind are so marked, owing to the sea being frozen to the south. At the winter quarters of the *Discovery* the variability was considerably less in winter and greater in summer than at the South Orkneys. In other words, the contrast between a sea and a land-wind was less in winter and greater in summer than at the South Orkneys. Cape Adair, some 460 miles to the north of the Ross Island, where the *Discovery* was frozen in for two years, was much under the influence of the sea, and here, as at the South Orkneys, there was a great difference in the temperature of sea and land-winds—a feature, however, being the high temperature associated with winds from the East-south-east, which partook of the nature of a Föhn. At Cape Adair the variability was apparently greater than at Ross Island, but the observations only extend over eleven months, and refer to a different period from the *Discovery's* records. At the winter quarters of the *Belgica* conditions of sea and ice distribution seem to be much the same as at the South Orkneys, although the latter station is nearly 10 degrees of latitude to the north of the *Belgica's* position. This is supported by the large difference on the *Belgica* in the mean temperature of the wind during the winter season, the South-west wind having a mean temperature of −9°.9, and the North-east (in which direction the open sea was nearest) a mean of 12°.6, a difference of 22°.5. As the lowest mean of all −12°.1 was recorded during calms, the greatest temperature change would occur at this season, when a calm was succeeded by a wind from the North-east. With regard to places in the Cape Horn region and in the ocean to the east, the temperature variability is greatly reduced, because conditions are in the main insular. To this there are some slight exceptions. At Ushuaia, in Tierra del Fuego, owing to the presence of high mountains and the station being at some distance from the open ocean, conditions are somewhat continental during the winter; while at South Georgia the relatively frequent occurrence of Föhn, and the comparative proximity of pack-ice to the east and south, are factors which increase the temperature variability at this station. These influences are not present at such strictly insular situations as the Falkland Islands, New Year's Island, and Orange Bay, where a small and steady temperature variability prevails at all seasons of the year, these relations being also in the Westerly wind system, where great variations in wind direction are somewhat infrequent.

AUSTRALIAN METEOROLOGY.—Sir Norman Lockyer and Dr. W. J. S. Lockyer have for some years past pointed out the presence of a barometric see-saw of short duration (about 3.8 years) which is nearly world-wide in extent, and they have shown that the pressure changes occurring from year to year in Australia were very closely similar to those taking place in India. Dr. Lockyer has subsequently directed attention to the fact that the mean amplitude of the Australian variation was nearly double that of the Indian change, and has further showed that this Australian pressure change amounted to nearly 35 per cent. of the mean annual variation, and must, therefore, play an important part in bringing about changes in the weather experienced from year to year. In the case of the pressure variation of long duration in operation in Australia, he has also pointed out that this fluctuation took about 19 years to complete a cycle, and its amplitude reached nearly 25 per cent. of the annual variation.

The importance of these changes, their possible periodicity, and their extensive distribution, have led Dr. Lockyer to make a more detailed enquiry into the Meteorology of Australia as a whole, and this has now been given in a memoir, "A Discussion of Australian Meteorology," published by the Solar Physics Committee. Australian weather is the product of a series of rapidly moving anticyclones, or high-pressure areas, which follow one another with "remarkable regularity," and are the great controlling force in determining local weather. These anticyclones move from west to east at an average rate of about 400 miles a day. In their passage across the continent the centres are not always in the same latitudes, but vary according to the time of the year, and the high pressure areas are very much larger in winter than they are in summer. As these anticyclones pass in rapid succession eastward, V-shaped depressions or

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cyclones follow in their wake both north and south of them. Thus the seasonal change of latitude of the high-pressure areas is a dominant factor in Australian weather throughout the year.

Dr. Lockyer makes a comparison of the mean annual pressure and rainfall variations, the frequency of "Southerly Bursters," the heights of the River Murray in relation to rainfall, etc. He concludes his memoir by discussing the relation of Australian pressure changes to variations in other parts of the world, and points out the similarity of air movements over South America, South Africa, South Indian Ocean, and Australia.

DURATION OF RAINFALL.—In the Report of the Fernley Observatory, Southport, for the year 1908, Mr. J. Baxendell has given not only the daily values of the duration of Sunshine, but also the daily values of the duration of Rainfall. The general public are accustomed to form their opinion as to the relative wetness of a place by the number of days on which rain falls in a month or year. This is not a fair criterion, as at times heavy rain may fall in a very brief period, while on other occasions there may be a very slight drizzle throughout the whole of the day, which would scarcely yield a measurable amount of rain. The following figures show the monthly results obtained at Southport during 1908 :—

1908.	No. of days with Rain (·01 inch or more).	Total Duration of Rain. Hours.	Mean Rate of Rain per rainfall hour. Inch.
January ...	15	45.4	.043
February ...	22	53.2	.040
March ...	18	88.2	.028
April ...	14	52.3	.046
May ...	18	44.0	.062
June ...	10	36.4	.053
July ...	17	55.3	.063
August ...	15	42.7	.078
September ...	17	63.6	.065
October ...	13	40.9	.056
November ...	15	41.3	.067
December ...	24	66.6	.037
Year	198	635.9	.051

MAGNETIC RESULTS FOR 1908.—From the annual reports of the various observatories which have come to hand we find that the principal results for the magnetic elements for 1908 were as follows :—

Greenwich Observatory.

Declination	15° 53′·5 W.
Horizontal Force ...	4.0184 (in British units). 1.8528 (in metric units).
Inclination (Dip) ...	66° 56′ 17″ N.

Falmouth Observatory.

Declination	17° 54′·7 W.
Horizontal Force ...	0.18798 C.G.S. units.
Vertical Force	0.43279 C.G.S. ,,
Inclination	66° 31′·4 N.

Stonyhurst Observatory.

Declination	17° 35′·7 W.
Horizontal Force ...	0.17434 C.G.S. units.

ORNITHOLOGY.

By W. P. PYCRAFT. F.L.S., F.Z.S., M.B.O.U., &c.

PROTECTION OF THE KITE IN WALES.—For some years the British Ornithologists' Union, aided by Lord Cawdor and Mr. A. Gwynne Vaughan, have made strenuous efforts to preserve the remnant of the kites that remain in Wales—the last stronghold of these birds in Great Britain. But for such efforts this fine bird would long since have been exterminated. As it is, it would seem, from the reports just made by the Rev. D. Edmondes Owen and Mr. A. Gwynne Vaughan, the birds, five pairs in all, are only just holding their own.

Last year, so far as the protected nests were concerned, the result was *nil*, and they hold out but little hope of a happier ending to the nesting season this year, though it began well. That pestiferous person, the egg collector, appeared on the scene of one estate where every effort is made to protect these birds, and some one or other of these unscrupulous thieves seems to have succeeded in robbing the nest. Carrion crows in feathers, as well as in human shape, are answerable for yet other destruction. And in one nest the eggs seem to have proved unfertile, probably because this pair are waning with age. In any case, there seems a danger of the stock coming to an untimely end through inbreeding, and it is much to be hoped that some enterprising naturalist will import fresh blood in the shape of a few young birds, or eggs, from the Continent. These last could be placed either in kites' nests, or in those of buzzards.

BROWN FLYCATCHER IN KENT.—A male of the Brown Flycatcher (*Alseonax latirostris*), shot near Lydd, in Kent, on May 21, 1909, was exhibited at a meeting of the British Ornithologists' Club on May 26, by Mr. M. J. Nicoll, this making the first record of this species as a Briti h bird.

RED-RUMPED SWALLOW IN KENT.—Mr. Nicoll also exhibited a Red-Rumped Swallow (*Hirundo rufula*), which was shot at Jury Gap, near Lydd, on May 16, 1909, making the second addition to this species in the British list.

HOOPOE IN NORTH HANTS.—Mr. A. J. L. O'Beirne, in the *Field* (May 29), records the fact that while driving from Brackley to King's Sutton on the 19th of the month, he saw a Hoopoe in a cornfield, between Brackley and Charlton. As the editor pertinently remarks, but for the collector, these birds would breed annually with us.

RUFFS IN NORFOLK.—Miss E. L. Turner, in *British Birds* for June, gives a short but lively account of her good fortune at Hickling, Norfolk, when, on May 6, she had the rare privilege of watching large numbers of Ruffs and Reeves flying about over the marshes, sometimes dropping down to feed, and at others wheeling round overhead. For several days in succession she came across "little batches of these birds standing about in the shallows, or feeding."

BIRD MARKING AND MIGRATION.—In the June issue of *British Birds* the aid is invited of all who are interested in the solution of the thorny problems of migration. The editors have prepared a large number of aluminium rings properly and eligibly stamped and dated, and these will be sent, with schedules containing records of the rings used, to all who may wish to help. The rings, we need hardly remark, are to be placed round the legs of nestling birds of all kinds, and if due care is taken in registering the disposition of these rings valuable results should in course of time reward the operator. Already some 1,500 rings have been sent out, but the more extensively the good work is carried out the more valuable, because the more reliable the results will be. We hope that many readers of "KNOWLEDGE" may be induced to take a hand in thus endeavour.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

ABSORPTION OF CANARY GLASS.—Mr. R. C. Gibbs has recently extended our knowledge of the absorption and fluorescence of canary glass. The essential results he states as follows :—

1. Increase of temperature produces an increase in the absorption in the greater part of the spectrum measured and a widening of the absorption band.

2. There is a large and irregular shaped fluorescence band in the yellow-green portion of the spectrum and a smaller band in the violet.

3. The typical fluorescence for the larger band shows for increasing temperature a slight shift in its maximum towards the red.

4. The changes in the typical fluorescence when the glass is heated seem to indicate that the yellow-green band consists of two or more overlapping bands which are affected differently by a rise of temperature.

5. The glass shows a somewhat higher intensity of fluorescence, especially in the region of the main band immediately after cooling than before heating. It then gradually returns to its normal value.—(*Physical Review*, May, 1909.)

LONGITUDINAL PRESSURE OF SOUND WAVES.—To exhibit this pressure, Mr. Elmer E. Hall mounts a mica vane (two or three centimetres square) on one end of a thin horizontal glass fibre suspended with quartz fibre, the other end being loaded with wax. A brass rod is held firmly with one end near the vane. When a vibrating tuning fork is held firmly against the rod a deflection is obtained showing that the vane is pushed away from the rod. The deflection is observed by the usual mirror method.

It may, perhaps, be doubted whether the phenomenon so obtained is, in reality, an exhibition of the simple pressure of radiation as usually understood. That is to say, the disturbance in the layer of air intervening between the rod and the vane is probably of a much more complicated type than is contemplated in the simple reflection of a longitudinal wave. Be that as it may, the experiment is interesting as showing the existence of a force at each instant which does not cancel itself, on the whole, during an entire period.

THE HEAT TAKEN IN IN WARMING A SOLID.—Previous attempts to apply the electron theory to the case of electrical and thermal conduction have involved that the transfer of heat by thermal conduction should be effected entirely by the electrons, the molecules of the solid forming merely a sort of framework through which the electrons moved. Moreover, it was found that the heat needed to warm the body was not more than that required to warm the electrons in it. These conclusions were based on the assumption that the electrons behave in the solid in much the same way as if they were molecules of a practically perfect gas. Professor Jeans now endeavours to make the theory more complete by developing it without assuming the existence of free paths and collisions—a much needed step in the right direction. The changes made, however, leave the prior conclusions practically untouched. There seems no escape, then, from the view that the specific heat of a solid is really the specific heat of the free electrons it contains. The atoms form a framework which is continually set into vibration by collisions with the electrons, but its motion is dissipated into radiation so rapidly that the atoms never acquire a motion comparable with temperature-motion.

In this connection it may be pointed out that it is fundamentally assumed that when different kinds of molecules come into temperature equilibrium the kinetic energy of each kind of molecule is, on the average, the same. Jeans suggests that the molecules of the substance form large clusters; each such cluster would, then, take up only as much of the energy as a single electron. If the clusters are sufficiently large the number of them will be sufficiently small to make the total energy taken by them negligible compared with that taken up by the electrons.—(*Phil. Mag.*, June, 1909.)

ZOOLOGY.

By R. LYDEKKER.

LUNGS OF THE TAPIR.—Only a short time ago was it announced that elephants differ from other mammals in the absence of a pleural cavity, that is to say, that their lungs, in place of being enclosed in a membranous bag, are closely adherent to the walls of the chest. In the latest issue of the Zoological Society's *Proceedings* Mr. Beddard states that the same condition obtains in the Malay tapir (why will he call it the "Indian" tapir?), adding that a previous observer had recorded the same fact, but attributed it to disease. It would be of great interest to ascertain the reason for this departure from the normal, and still more why it should occur in groups of animals so apparently widely sundered as are tapirs and elephants.

THE CALLOP OF THE HORSE.—A statuette of the American thoroughbred "Sysonby" has recently been placed in the north hall of the Natural History branch of the British Museum in order to exhibit the true position of the limbs in a galloping horse; this, owing to the rapidity of the action, not being seen by the human eye. Just, however, as the individual spokes of a rapidly-revolving wheel can be made visible at night by a flash of lightning, so the action of a galloping horse can be analysed by instantaneous photography.

The model of "Sysonby" has been made from photographs taken at the instant when all four legs are off the ground at once. At this stage of the action the back is somewhat arched, and the hind feet are directed forwards and the front ones backwards, so that both pairs are tucked under the animal's body. When the limbs again touch ground, the first to do so is one of the hind feet, which is thrust far forwards, so as to form an acute angle with the line of the body, and thus serve the purpose of a spring in breaking the force of the impact of the hoof when the horse is going at top speed.

In the conventional mode of representing a galloping horse all four legs are off the ground at once, but the front pair are stretched forwards to their utmost capacity, while the hind pair are extended backwards in such a manner that the under surfaces of their hoofs are directed skywards, the body being at the same time brought near to the ground.

This conventional pose appears to have been derived from a dog running *ventre-à-terre*, when the front and hind pairs of limbs are respectively extended forwards and backwards, with the soles of the hind feet turned upwards. This pose, as Sir E. R. Lankester has recently shown, was adopted to represent the gallop of the horse by the goldsmiths of Mycenæ between 1800 and 1000 B.C., whence it was transmitted by way of Persia and Siberia to China and Japan, to return in the 18th century, as the result of commercial relations with the last-named country, to Western Europe.

PAPERS READ.—At the final meeting of the Zoological Society for the session 1908-9, held on June 15, Mr. Beddard discussed certain points in the anatomy of the lesser ant-eater, while Mr. Burne did the same for the walrus; the Secretary also contributing a note on the young walrus recently living in the Society's Garden. A new decapod crustacean, obtained by Mr. C. W. Andrews in Christmas Island, formed the subject of a communication from Mr. Calman.

REVIEWS OF BOOKS.

ASTRONOMY.

The Heavens and Their Story, by A. and W. Maunder (London: Robert Culley, 1909; pp. 357, with 8 coloured plates and 89 other illustrations; 5s. net).—In introducing this work we cannot do better than quote the authors' advertisement summary: "This is not a text-book to teach the student the science of Astronomy; it is a re-telling of a few of the stories told by the heavenly bodies, so that those who will may read them for themselves. At first the readers of the stories written on the heavenly page are asked to take their stand as their forefathers did, without any instruments but their own two eyes, the open sky, and the horizon line. Then there is brought to them the assistance of the telescope, the spectroscope, the sensitive plate, and the magnetic needle; and by these means the sun tells the stories of his surface, of his surroundings, and of his effect on the earth, or of the earth upon him. By these means also his family tell their stories—the stories of Jupiter, Saturn, Mars, Venus, the Moon, and the Comets. Finally we read something of the spaciousness, something of the magnificence, of that great house that God has builded—the Starry Universe."

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Mr. Maunder commences, as might be expected of the author of "Astronomy Without a Telescope," with a simple exposition of the elementary forms of celestial motion, as shown to an observer on the Hilly Fields, one of the comparatively recent "lungs" of South London, a splendid position for the purpose with its abrupt descent, extensive views, studded with well-known landmarks, of which full use is made in illustrating the march of the seasons. How much further than this he proceeded is not clear, but the doctor's fiat intervened and the bulk of the work had to be entrusted to the very competent hand of Mrs. Maunder. How many writers on Astronomy or any other subject could thus delegate the completion of a work in such a way, in the full confidence that it would not suffer? How completely confidence was justified will be instantly recognised by every intelligent reader. As will be seen by the numbers given, the book is exceedingly rich in illustrations, some, of course, familiar, but none the less well chosen, and a gratifying number of them simply explanatory of some important principle. The four divisions of the book are of nearly equal length, and may be termed Celestial Motions, Sun, Planets and Stars, and Nebulæ. It is not easy to find a peg on which to hand the smallest complaint, as the authors show an encyclopædic knowledge of the details of their subject. We believe that, though not universal, the more logical practice is to define a gradient by the sine and not by the tangent. We are also not quite satisfied with Plate LV., Fig. 2 *b*. But even the sun shows *some* spots, and with this analogy we can only suggest that the book represents a marked minimum. Apropos the subject of sunspots and their connection with terrestrial magnetism, a subject both the authors have already made peculiarly their own, this is very well treated in their book, as was only to be expected. With so large a number of plates there was a risk of making the book as heavy, speaking in a literal, not literary, sense, as some recent American publications, but this has been, to a great extent, minimised by the device of using both sides of the plates except the eight coloured ones. We trust that "The Heavens and Their Story" may induce many to read the stories for themselves. Those to whom the Hilly Fields are not familiar will find them quite worth a visit if they wish to follow the authors closely throughout, but, of course, they are only giving a more convincing, because actual, illustration, and any reader can construct an alternative scheme on any suitable hill in his or her own neighbourhood.

Cambridge Observations, Vol. XXIV., Part 1. Measures of double stars made with the Northumberland Equatorial of the Cambridge Observatory under the direction of Professor Challis in the years 1839-1844. Now published for the first time (Cambridge: University Press, 1908; pp. vi. and 39; 5s. net).—It seems a great pity that these observations were not published earlier, as they represent measures made with what was at that time the most powerful instrument in the country (for which reason the search for Neptune was shortly afterwards entrusted to Professor Challis). That they are published now is due to the accidental discovery of the manuscript in incomplete form some 60 years after the dates involved. Better late than never.

We have received a Star Calendar for 1909 on four sheets, published at 1s. net by Hirschfeld Bros. and edited by H. P. H. (Mrs. H. Perriam Hawkins).

BIOLOGY.

Nutrition and Evolution, by H. Reinheimer (London: J. M. Watkins, 1909; pp. xiv. and 284; price 6s. net).—In this work the author deals with nutrition from the evolutionary standpoint, computing its effects by dynamic methods. The organism and its environment are considered as affecting each other according to the laws of action and reaction, and a number of concise and well-drawn definitions are introduced, among which reference may be specially made to the one concerning polarity. Variation, survival, prepotency, Mendelism, population, and sex receive in turn more or less detailed attention. Stability and degeneration in minerals and various phenomena of plant-life alike enter into the scheme of the book; and in connection with the second of these subjects it is demonstrated that in-breeding is correlated with in-feeding. Finally, it is concluded that by a reduction of physiological impediments, an increase in human stature may apparently be effected. The work may be commended to all serious students of the subject, but it is not one for the ordinary *dilettante* reader.

BOTANY.

Illustrations of the Cyperaceæ; prepared under the direction of the late C. B. Clarke, F.R.S. (Williams and Norgate; 12s. net).—The book consists of 144 plates, accompanied by descriptions of the figures, which were intended by the author to illustrate a monograph of the Cyperaceæ, the preparation of which had occupied a large amount of time during the last twenty-five years of his life. The manuscript proved, on examination, too extensive for immediate publication, but his descriptions of new species, along with a sketch of the classification adopted by the author, showing his ideas respecting genera, and species grouped under each sub-division, were published in the *Kew Bulletin*, September, 1908. The plates consist of figures and dissections of species typical of the genera considered by the author as typical, and along with the published sketch of classification indicated above, give a clear idea as to the views held by one who was universally acknowledged as the supreme authority on matters relating to the Cyperaceæ. The figures are bold and clear and convey just the information required by the systematist.

A Tourist's Flora of the West of Ireland, by R. Lloyd Praeger (Dublin: Hodges, Figgis and Co., Ltd.; 3s. 6d. net).—Every botanist knows full well that the author knows perhaps more respecting the botany of Ireland than anyone else; there is no corner of the country with which he is not familiar, and no amount of labour is considered too much to expend over the verification of a botanical problem. The pith of this knowledge is given in an altogether unusual, and much superior, manner to what we encounter in the stock botanical guide. It may be improved upon in course of time, but at present it is unique in its superiority over all others. The illustrations and maps are numerous and excellent. Plate I., "Northern and Southern Plants in the West of Ireland. The Alpine-Arctic *Dryas octopetala* and the Mediterranean *Habenaria intacta* at Ballyvaughan, Co. Clare," suggests the nature of the problems that the botanist may expect to meet with in the West of Ireland.

The Hedge I Know, by W. P. Westell, F.L.S., and H. E. Turner (J. M. Dent and Co.; 8d.).—An excellent little book. Amongst the many so-called "Nature Study" productions at the present day, if there is nothing to unlearn we are truly thankful, but in this book it is evident that the authors possess first-hand knowledge, and furthermore possess the faculty of presenting such knowledge in a manner that will appeal to youngsters, and rouse a desire not only to verify the statements made but to discover new points for themselves. The illustrations are numerous and good.

The Book of Nature Study, Vol. III., edited by J. Bretland Farmer, M.A., D.Sc., F.R.S. (The Caxton Publishing Company).—Vol. III. deals with plants, and, as would be expected from the positions held by the editor and his colleagues respectively, is in every respect accurate and up-to-date, differing markedly in this respect from the multitude of recent books dealing with the same subject. A definite scheme is kept in view throughout the book, hence there is no anticipation or interpolation of facts that are only explained in some following chapter, and the reader who honestly follows the course of instruction given will be in a position to benefit by the study of more advanced works dealing with plant life. In dealing with the study of plants from any standpoint whatever we are undoubtedly studying Nature, but during recent years the term "Nature Study" has been narrowed down to a study of plants or animals in their own haunts, after the fashion of Gilbert White. This line, however, is not followed in the book under consideration. There is an academic tone throughout, and although every sentence is to the point, the style savours of the class-

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room and laboratory, and it must be admitted that the authors are much more at home in the laboratory than in the field. Farmers will learn, probably for the first time, that "one reason for planting hedges round fields is to protect the young crops from the strong, often very cold, March winds, which might injure the seedlings irreparably." The first four chapters are devoted to the general structure, functions, and modifications, to meet special requirements, of plants generally, one of these, "The Importance of Hairs in Plant Life," being admirably adapted to stimulate observation on the part of the student. Perhaps too much stress is laid on the modification in amount of hairiness to suit special conditions of temperature, moisture, etc., without some qualification, it sounds so feasible, and in the examples given will be found to be correct, that the student will receive a shock during his first ramble amongst plants generally to find very hairy plants growing side by side with other kinds that are perfectly bald, and both obviously perfectly at home notwithstanding. The remainder of the book is devoted to "Some Common Flowering Plants," and consists of a detailed account of the general structure and mode of life of readily available examples of spring and early summer wild plants—or flowers as they are termed. There are numerous figures in the text, in addition to sixteen whole plates, seven of which are coloured.

NATURAL HISTORY.

The Cambridge Natural History, Vol. IV. (London: Macmillan and Co., Ltd., 1909; pp. xviii and 566, illustrated; 17s. net).—With the issue of the volume now before us the "Cambridge Natural History" is brought to a conclusion, and it is with great pleasure that we congratulate Messrs. Harmer and Shipley, the editors, on the completion of their labours. The work fills a long-felt want, occupying as it does a position between the popular "Royal Natural History," on the one hand, and Lankester's extremely technical "Treatise of Zoology," on the other; each of these works being supplemental to the other two, and no biological library being complete without all three. The one fault of the "Cambridge Natural History" is the inequality in the treatment of their respective subjects by the authors of the different volumes; some groups, like the birds, being treated in a very popular style, while others, as in the volume before us, are described in much more technical style and detail. As a happy mean we may cite the two volumes on Insects, by Dr. D. Sharp. With this exception, we have nothing but praise to accord to this invaluable natural history. The fourth volume, of which the issue was delayed owing to the untimely death of the late Professor Weldon, treats of crustaceans, spiders, scorpions, and their allies, and is the work of six different authors, who have combined to produce a most excellent result. To criticise such a work would obviously be out of the question in the space at our command; and we must therefore perforce confine ourselves to a few desultory remarks. The section on Crustacea contains one chapter by the late Professor Weldon, who had undertaken the whole subject, but the remainder has been written by Mr. Geoffrey Smith. Although there are certain differences in the classification, Mr. Smith's account in some degree supplements the one given by Dr. Calman in the volume on Crustacea, in Sir Ray Lankester's "Treatise," which is almost wholly morphological. We find, for instance, in Mr. Smith's section, mention of the important fact that crayfishes are apparently absent from the rivers of Africa, a statement for which we may look in vain in the other volume. The excellent introduction to the Arachnida, and the account of the king-crabs are contributed by Mr. Shipley, who is likewise responsible for the chapters on Tardigrada (water-bears) and Pentastomida. The description of the scorpions, spiders, mites, ticks, etc., has, however, been confided to Mr. Cecil Warburton, who has incorporated much of the information recently acquired with regard to the last of these groups. Mr. Henry Woods has undertaken the extinct groups of trilobites and euripterids, or giant sea-scorpions. The trilobites are, it may be remembered, regarded as a main group, placed between the crustaceans and the arachnids; but the euripterids are included in the latter class, although no one would infer this from the title-page, which in this respect we regard as distinctly misleading. Lastly, Professor d'Arcy Thompson describes the so-called sea-spiders or pycnogonids in his usual clear and masterly style. With a repetition of our sense of its great value and the indebtedness of all naturalists to its editors and their contributors we take leave of the "Cambridge Natural History," at all events till such time as a new edition is demanded.

PHOTOGRAPHY.

The Photography of Coloured Objects, by C. E. Kenneth Mees, D.Sc. (Croydon: Wratten and Wainwright, Ltd., 1909; pp. vi. and 69; price 1s. net).—This brochure will be found of interest and value by all those who are concerned with the subject it treats of, whether their work is of the nature of landscape, portraiture, photo-micrography, or general trade and technical work. The author refers only to the plate and the colour screen, and describes in a clear manner the principles involved in their use. But he goes beyond mere principles and gives practical details with examples, applicable to the numerous kinds of work in which the photography of coloured objects takes part. The importance of having red sensitiveness when photographing furniture, the actual disadvantage of the want of green sensitiveness of the usual type of orthochromatic plates, the rules that govern the multiplying factor of colour screens, methods of exaggerating and reducing colour contrast, and other such subjects are dealt with. Although published by the well-known firm of plate makers, of which Dr. Mees is a member, the volume is not an advertisement of his firm's productions. He refers to them where occasion demands it, and such specific references will be found of very much more use than the generalities that might have taken their place.

MISCELLANEOUS.

A Guide to Avebury, by K. Hippisley Cox (London: Edward Stanford; 68 pp., small quarto; 2s. net).—This work is something more than a guide, and will serve as an excellent handbook to accompany the visitor to what Lord Avebury says, in his interesting preface to the book, is to the archæologist the most interesting spot in England: "It is the greatest megalithic monument in the world, and Silbury Hill, with which it is associated, which covers 5½ acres, and is 130 feet in height, is the greatest burial-mound in Europe." The conclusion come to is that Avebury was the tomb of some great chief, but that its very size precluded its completion. It was impossible to raise a mound which should cover it, the understanding being that this and similar megalithic monuments were intended as the framework, so to speak, of the mound which should have been reared above it. There are some useful maps in the book, and plans of various earthworks in the neighbourhood.

An Elementary Treatment of the Theory of Spinning Tops and Gyroscopic Motion, by Harold Crabtree (London: Longmans, 5s. 6d. net).—This is a most welcome book. The matter of which it treats is usually considered either in very elaborate text-books or else in those so popular as only to be of limited use. Anyone who has read Perry's excellent lectures will want to know something more about the subject; the present volume is precisely the place in which he will be able to find it without having his mathematical attainments too much called upon. Of course, the reader must expect to find the subject not a light one—it is essentially complicated. But Mr. Crabtree knows how to use diagrams as an aid to the mathematical imagination, and as most people are acquainted with the most conspicuous phenomena of spinning-tops, gyrostats can be purchased for sixpence, and diabolo spools were recently on the market, the reader can have at his command the greater part of the apparatus necessary for obtaining the phenomena himself and thus supplementing his reading. When we point out that the book includes such subjects as the steering of a torpedo, Schlick's method for steadying vessels at sea, and Brennan's mono-rail, it will be seen that it deals with topics which are alive. We have looked carefully through the explanations, and consider them to be most thoughtfully and accurately made.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

Royal Microscopical Society.

May 19.—J. F. Cheshire, Esq., Vice-President, in the chair. A paper by Mr. Edward Heron-Allen and Mr. Arthur Earland "On the Foraminifera of the Shoresands of Selsey Bill," Part II., was taken as read. Mr. J. W. Gordon exhibited a new speculum illuminator for the microscope. It consists in principle of a glass rod, one end of which is ground and brought within half an inch of an electric lamp of the tubular form, so that the source of light is taken from the strongly illuminated, but small, circular, ground-glass disc, with reflections from the sides of the rod. The lamp exhibited had certain improvements by which various adjustments in position could be made with facility, and, in particular, an arrangement by which the intensity of the light could be varied by varying the distance between the speculum and the electric lamp. The designer claims for this lamp that it gives a circular, structureless disc as a source of illumination, which can be made to give as large or as small a field of illumination as is desired, and which, whatever the focussing of the condenser, never produces unsymmetrical diffraction and never exhibits any disturbing structure; that the intensity of the light is completely under the operator's control, without interference with the focal adjustments of his system; that the adjustability of the lamp as to height enables the centring to be done with the utmost precision; and that the mechanical construction of the stand obviates the necessity for guides controlling the movements of the lamp-chamber. A large number of objects, mostly representative of pond life, were shown by members of the Quekett Club, and others, amongst which should be mentioned blood from rat showing living trypanosomes, and living typhoid bacilli shown under dark-ground illumination by Mr. J. W. Ogilvy; *Volvox globator*, showing irregularity of outline of cells and protoplasmic contents, × 200, shown by Mr. J. H. Pledge; *Volvox aureus*, showing also pigment spots in cells at anterior pole under $\frac{1}{12}$ inch oil immersion objective, shown by Mr. W. J. Scourfield; Cyclosis in Vallisneria with $\frac{1}{40}$ inch apochromatic oil immersion objective, shown by Mr. T. H. Powell; and a very beautiful exhibit by Mr. C. J. H. Sidwell, in which the constant current from anterior to posterior pole set up by the cilia of *Volvox globator* was demonstrated, × 150, by means of granules of carmine in suspension in water.

Quekett Microscopical Club.

June 4.—Mr. C. Lees Curties, F.R.M.S., exhibited for Mr. Walter Bagshaw a specimen, one of several found in the same gathering, of *Navicula lyra* showing abnormal markings.

Mr. F. Martin Duncan, F.R.P.S., gave a lantern lecture dealing with "The Romance of Forest Life." He deplored the depredations of the professional collector, and said that it was greatly to be desired that the New Forest area, to which his remarks had chiefly applied, should be made into a reservation for the many fast-dwindling species of animals and plants of the British Isles.

The next ordinary meeting of the Club, the first under the new arrangement, will be held on *Tuesday*, October 26, 1909.

The Microscope in Engineering.

Under the above title Mr. Walter Rosenhain contributes to a recent issue of "Nature" an interesting review of the progress made during the past ten years by the young science of metallography, or the application of the microscope to the study of sections of metals, a branch of microscopical science which has proved of so much value that it is now a recognised method of investigation of proved practical utility, and, as such, has succeeded in obtaining recognition both by manufacturers and users. A summary of Mr. Rosenhain's article will be of interest to many. He naturally lays stress on the study of the nature and causes of breakages of metals or other failures occurring in practice as being the most important and fruitful subject for microscopical investigation, and for this purpose sections are made not only at the actual site of fracture, but at some distance away. The first section will often show evidence of local weakness in the metal at the point of actual fracture, or even of the method by which the fracture was produced, the section of a fracture due to a sustained stress being quite different to one produced by shock or repeated alterations of stress. A practical difficulty may be introduced, however, by the fact that the site of fracture is usually either corroded or worn away by subsequent friction.

Again, evidence may be obtained of unsuitable treatment during manufacture, such as over-exposure to high temperatures, or of too long heating, which leaves its trace in the form of a coarse, angular structure, readily recognised in such materials as steel, brass, or bronze. In the same way evidence may be obtained of insufficient rolling or forging, or of working at too high or too low a temperature. The microscopic evidence is generally quite sufficiently conclusive, but confirmatory tests are advisably made by means of chemical analysis and "dynamic" and "static" mechanical tests. Mr. Rosenhain considers that the inclusion of a microscopical examination amongst the regular tests carried out on engineering materials would not impose upon manufacturers an additional onerous difficulty in complying with specifications, as the mechanical requirements of the engineer might be shown to be met by a more favourable structure rather than by a certain pre-determined chemical composition. Moreover, by means of the microscope the engineer would be able to rely more securely both upon the uniformity of his materials and upon their conformity with test specimens, the microscopic examination of a number of very small pieces supplementing the mechanical or chemical tests of samples selected from the bulk and showing whether the bulk was fairly represented. This, again, would prove of service to manufacturers. Want of uniformity in the materials forming different parts of the same casting would also be prevented, whether due to unequal distribution of the constituents of the metal, to impurities, or to internal stresses set up by faulty methods of working. The microscope has, in particular, proved of much service in controlling annealing processes in connection with copper and its alloys, elaborate "equilibrium diagrams" of the more important alloys of copper having been worked out, showing the result of adding one element at a time. In the same way the effects of exposure to certain temperatures, followed by either rapid or slow cooling, have been

determined, and, as a result, the manufacturer is able to treat his alloys at the right temperatures, and to control the results with ease and certainty by examining a few specimens under the microscope. At present this method of control is applicable only to alloys consisting of two metals, the more complex alloys being as yet not worked out and requiring other preliminary but difficult scientific investigations, but even with these alloys empirical data as regards the best micro-structure and treatment are available and are of considerable service. When so much valuable work has been done by a means of investigation which is as yet little more than twenty years old, Mr. Rosenhain is surely justified in believing that the future will see its still greater development, both as a means of examination and of investigation.

Mounting Rotifers and Other Organisms in Canada Balsam.

The Rev. Eustace Tozer exhibited a few months ago to the Royal Microscopical Society a series of slides of *Brachionus*, *Hydatina*, *Floscularia*, *Œcistes stygis* (extended from tube and showing wreath of cilia), *Pterodina*, and *Euglena*, which were double stained and showed no shrinkage, but which had been mounted in Canada balsam. A *résumé* of his methods will be of service to many workers, who may hitherto have used only liquid methods of mounting, and they have the advantage of being very simple. To get the Rotifers in quantities they were placed in shallow saucers covered with glass, away from direct sunlight. Clean pond water is best, and *Euglena* is given for food, success depending upon a good supply of food. Under these circumstances the Rotifers breed rapidly and may be picked off the surface of the water with a penknife. A drop of osmic acid let fall on the water on the slide suffices to extend and fix many of the organisms ; three drops of 10 per cent. cocaine added at intervals will answer for many ; others are amenable to picric acid added at intervals. Formalin added slowly extends the jaws of small sea-worms, whilst formalin vapour, manipulated with watch-glasses, is the best fixative for flagellate zoospores and the monads of infusions. Glacial acetic acid differentiates the jaw parts of Rotifers, revealing the most minute structure, and is very useful for the study of kinetic phenomena in Rotifer eggs. The Rotifers may be left in it for eight hours, after which it must be thoroughly washed out with alcohol. Unless carefully applied it shrivels the cilia. When the Rotifers are transferred to the slide, after fixing by osmic, cocaine, or picric, the cover-glass is put on, a thread of white cotton being placed across and under one end to prevent the specimens being crushed or washed away, and to facilitate subsequent treatment. The water is then drawn off by blotting-paper at one end of the thread, and osmic acid applied at the other. When the specimens are immersed in the osmic, the stain, picro-carmine or eosin, is added, these two stains preventing the osmic from blackening, and the picro-carmine assisting the osmic to differentiate. Staining and hardening are thus combined. The slide is then put into a dark, moist chamber to prevent evaporation, a couple of saucers being suitable, the lower one containing water, and covered with a square of glass upon which the slide rests, and the upper one being moistened. The time required for hardening varies with different forms : *Brachionus*, 5 hours ; *Hydatina*, 12-14 hours ; *Œcistes*, 24 hours ; *Floscularia*, 3 days ; amoeba (with picric acid), about 10 hours. After hardening, the specimens are washed by repeating the irrigation method, and left in the water for about 15 minutes, counter-staining with eosin being suitable here. They are then dehydrated with absolute alcohol by the same method, and left in the latter at least an hour to clear all trace of acid, which would cause shrinkage when oil is applied. Oil of cloves has been found to be the best clearing agent for this purpose, and the method of application is the same as in the foregoing. The specimens are left in it for half-an-hour, and may meanwhile be adjusted in position. The slide is then tilted to drain off the superfluous oil, the smallest quantity of xylol added, then the Canada balsam, and after a few minutes the warmed cover-glass. If possible, however, it is best to mount on the cover-glass. *Hydra viridis* may be mounted by putting the specimen on a slide in water with cover-glass and cotton, and allowing it to extend naturally, then applying the smallest possible quantity of absolute alcohol, letting it reach the animal at its base, where it is least sensitive, so that it will stretch and die. Dehydrate at once, harden in absolute alcohol for an hour or so, replace the alcohol with water to stain, stain with picro-carmine 1 hour, counter-stain with Heidenhain's haematoxylin 15 to 30 minutes, wash, dehydrate, apply the oils, and mount in balsam. It may be necessary to use graded alcohols if absolute alcohol gives trouble in any of the above methods.

Notes and Queries.

H. K. Fredriksstad (Norway).—It is not easy to answer your query as to "the most practical handbook on Algæ, Diatoms, Desmids, Fungi, Lichens, Mosses, and other of the lower Cryptogamia," unless I know whether you approach the subjects referred to from the point of view of an absolute beginner, or of one who has already gained some experience and who now requires assistance in carrying his studies further, naming specimens, etc. Under any circumstances I am afraid no single book known to me would cover the whole ground referred to save in a very sketchy manner. Perhaps the second volume of "Carpenter on the Microscope," published separately by Churchill at 14s., would be as suitable as any, but it deals with all branches of Nature under the microscope. There is a very handy little set of elementary books published by Sonnenschein at 1s. each, and these include separate volumes on Mosses, Fungi and Lichens, Ferns, Pond-Life (including Algæ), and Sea-weeds. Cooke's "Microscopic Fungi," published by W. H. Allen and Co., is also a useful book, and contains many coloured plates. If I may assume from the catholicity of your interests that you have little knowledge of the groups referred to, but are wishful to begin collecting, I think the above list of books would be as suitable as any. If you want more advanced works I shall be pleased to try and help you.

Messrs. Ernst Leitz have sent me two German catalogues, just published, of their most recent microscope models, and of new apparatus, one or two of which, being of interest, I shall hope to be able to describe in an early issue of this journal.

Messrs. A. E. Staley and Co. send me a list of microtomes and accessories, made by Bausch and Lomb, of New York, the prices of which have been reduced so that they now compare favourably with those by other makers, whilst the design shows several distinctive features. Amongst these may be noted the ingenious arrangement in the large microtome of the Schanze type, by which the whole of the mechanism carrying the object, including the automatic feed, is borne on slides which enable it to be shifted to any part of the microtome. Professor Minot's new and massive microtome, with knife supported on a rectangular frame and with object holder running on horizontal bearings beneath, deserves notice for those requiring a microtome of the utmost rigidity and precision.

Messrs. John Wheldon and Co. send me a catalogue of second-hand zoological books, comprising Vertebrata (exclusive of Aves), Marine Biology, etc.

[Communications and inquries on Microscopical matters should be addressed to F. Shillington Scales, "Redcourt," Adams Road, Cambridge. Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for July.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.49 and sets at 8.18; on the 31st he rises at 4.23 and sets at 7.49. On the 4th at 4 a.m. the earth is at its greatest distance from the Sun, the solar parallax then reaching its minimum value of 8″·66.

Sun spots may usually be observed on the solar disc in spite of the declining solar activity; at the time of writing two large spots are visible in the S.W. quadrant, and should they survive the semi-rotation, they will be available for observation early in the month.

The positions of the Sun's axis, equator, and the heliographic longitude of the centre of the disc, are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
June 30 ..	3° 11′W	2° 53′	354° 0′
July 10 ..	1° 22′E	3° 57′	221° 39′
,, 20 ..	5° 50′E	4° 54′	89° 19′
,, 30 ..	10° 3′E	5° 43′	317° 2′

THE MOON:—

Date.	Phases.	H. M.
July 3..	○ Full Moon	0 17 p.m.
,, 10..	☾ Last Quarter	6 58 a.m.
,, 17..	● New Moon	10 45 a.m.
,, 25..	☽ First Quarter	11 45 a.m.
,, 7..	Perigee.	8 0 p.m.
,, 23..	Apogee.	6 18 a.m.

OCCULTATIONS.—The following occultations are visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
July 1	39 Ophiuchi ..	6·0	8 29	128°	9 40	263°
,, 5	33 Capricorni	5·6	10 48	48	11 49	283
,, 25	2 Libræ ..	6·3	7 47	119	9 3	295

THE PLANETS.—Mercury (July 1, R.A. $5^h\ 18^m$; Dec. N. 19° 1′. July 31, R.A. $8^h\ 23^m$; Dec. N. 20° 55′) is a morning star in Gemini. On the 8th the planet is at greatest westerly elongation of 21° 11′ from the Sun, when he rises at 2.38 a.m.

Venus (July 1, R.A. $7^h\ 54^m$; Dec. N. 22° 17′. July 31, R.A. $10^h\ 21^m$; Dec. N. 11° 55′) is an evening star in Cancer, setting at 9 26 p.m. on the 1st and 8 52 p.m. on the 31st, thus for all practical purposes the planet is invisible.

Mars (July 1, R.A. $23^h\ 33^m$; Dec. S. 6° 54′. July 31, R.A. $0^h\ 20^m$; Dec. S. 3° 4′) rises on the 1st at 11.27 p.m and on the 31st at 9.56 p.m. The planet is becoming favourably placed for observation and increasing in brilliancy, so that the polar cap and some markings may be discerned in telescopes of about 3 inches aperture.

The southern hemisphere of Mars is inclined towards the Earth, thus, the South polar cap is visible, but since the summer solstice of the Martian Southern hemisphere occurs on September 14, the polar cap is rapidly diminishing.

The planet is in opposition to the Sun on September 24th, when the observing conditions will be the most favourable since the opposition of 1892, on account of the nearness of the planet to the earth.

Ceres is in opposition to the Sun on the 13th, appearing as a 7th magnitude star, low down in Sagittarius.

Jupiter (July 1, R.A. $10^h\ 46^m$; Dec. N. 9° 2′. July 31, R.A. $11^h\ 6^m$; Dec. N. 7° 0′) is rapidly getting to the west and is only visible for a short time after sunset. On the first the planet sets at 11.0 p.m. and on the 31st at 9.11 p.m. The apparent diameter and hence the brilliancy are diminishing, the equatorial diameter now being 32″·3, whilst the polar diameter is 2″·1 smaller. Practically no satellite phenomenon is observable this month on account of the planet's apparent proximity to the Sun.

Saturn (July 1, R.A. $1^h\ 26^m$; Dec. N. 6° 24′. July 31 R.A. $1^h\ 30^m$; Dec. N. 6° 39′) rises at 11.18 p.m. on the 15th and is in quadrature on the 16th. The planet is situated in Pisces; the ring as seen in the telescope appears fairly open, the southern surface is visible and inclined to our line of vision at an angle of 13°.

Uranus (July 15, R.A. $19^h\ 22^m$; Dec. S. 22° 35′) is in opposition to the Sun on the 12th, hence about this date he appears due South at midnight. The planet is situated about 2° South-East of the star π Sagittarii, and although rather low down is otherwise well placed for observation. Its remarkable spectrum of broad dark bands is well worth the attention of observers, even though possessing small instruments.

Neptune (July 15, R.A. $7^h\ 14^m$; Dec. N. 21° 40′) is not observable this month, being in conjunction with the Sun on the 9th.

METEOR SHOWER.—The most notable shower in July is that of the δ Aquarids, which occurs on the 28th. The radiant is situated in R.A. $22^h\ 36^m$, Dec. S. 11°, and the meteors are slow with long tails.

The Perseid shower also commences about the 10th, the radiant being initially near o Cassiopeiæ.

TELESCOPIC OBJECTS (Double Stars, &c.):—5 Serpentis, XV.^{h} 13^m, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.^{h} 41^m, N. 15° 44′, mags. 3·8, 10; separation, 31″.

θ Serpentis, XVIII.^{h} 51^m, N. 4° 4′, mags. 4·0, 4·2, separation, 21″·6. Both are yellow, the primary being paler than the smaller star.

ξ Cephei XXII.^{h} 1^m, N. 64° 8′, mags. 4·7, 7; separation 6″.

δ Cephei, XXII.^{h} 26^m, N. 57° 57′, mags. 4·2, 7, separation, 40″. A pretty pair for small telescopes, stars respectively yellow and blue. It is also a typical short period variable star, not of the Algol type, the period being $5^d\ 9^h$, with a sharp rise from minimum to maximum in $1^d\ 9\frac{1}{2}^h$. There will be a minimum on the 3rd at 11 p.m., from which other minima and maxima may be calculated from the intervals given.

Cluster in Libra, M 5. A compact cluster situated about one-third of a degree North of the double star 5 Serpentis; it appears like a large nebulous star when viewed with a pair of opera glasses.

Cluster in Serpens, N.G.C. 6633; about one-third of the way from θ Serpentis to α Ophiuchi. The cluster is visible to the naked eye.

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